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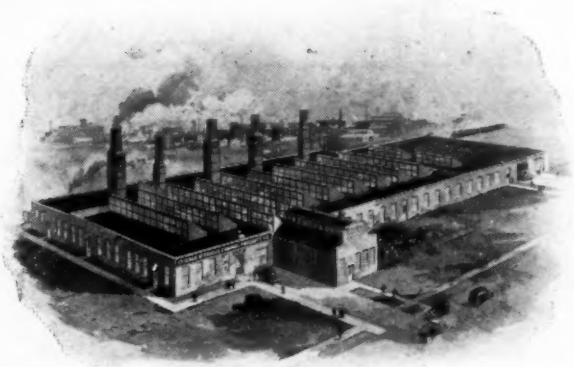

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ORIGINAL PAPERS

TESTS ON THE RESISTIVE QUALITIES OF SODA-LIME GLASSES TO WATER[1]

BY L. A. PALMER

ABSTRACT

A quantitative determination of the amount of alkali taken into solution after exposure for six hours to boiling water was made with a large number of soda-lime glasses.

Method.—The alkaline solution obtained after the six-hour treatment was titrated with 0.01 *N* H_2SO_4 until complete absence of color with either Phenol-Red or Brom-Thymol-Blue used as indicator.

A volume of the dilute acid equal to twice the volume required to destroy the color was then added, the solution was boiled twenty or thirty minutes and then titrated back to faint appearance of color with 0.01 *N* NaOH. The two indicators were used more or less interchangeably and with equally good results.

Relationship between Composition and Resistance to Water.—Various American bottles were studied. It was found that these glasses varied considerably in resistance to water and in composition. With respect to composition, the actual analyses having been computed to molecular percentage composition, the numerical magnitude of the reactivity coefficient (Zulkowski's formula), was found to be in general agreement with the number of cc. of 0.01 *N* alkali taken into solution during the six-hour test. The ratio of soda to combined lime, magnesia and alumina, all expressed in molecular percentage, was likewise larger in the case of glasses least resistant and diminished as the resistance of the glass to the solvent action of water increased. Glass of composition such that this ratio was less than 1.6 was found to have excellent resistant properties.

[1] Published by permission of the Director of the Bureau of Standards of the U. S. Department of Commerce.

Introductory

The work outlined in this paper is a continuation of that published by A. E. Williams[1] of the Bureau of Standards. Some significant facts were observed by him as regards the factors affecting the durability of glass articles in service. The purpose of these investigations has been to study the qualities of various types of American glassware and to devise standard methods of testing them. Under the direction of Mr. Williams I have undertaken to develop a simple method of measuring the resistance of various types of American glassware and from such data to study and compare them. The method consists in determining the amount of alkali taken into solution by the chemical action of boiling water on the finished glass article. From data compiled by Foerster[2] it is shown that while the amount of alkali taken into solution by water does not show the total matter in solution yet it does show that a determination of this alkali will give a fair means of judging the comparative resistances of glassware.

Since it has been found that the quantity of alkali in solution after sterilization or after a long period of storage is appreciable in the case of glasses of low resistance, and that this quantity is more dependent upon the composition of the glass than upon any other factor, the importance of having some quick and simple means of testing the resistance of glassware can easily be seen.

Previous Work

The resistance of various types of chemical glassware to the action of water has been thoroughly investigated by P. H. Walker and F. W. Smither[3] of the Bureau of Standards. In obtaining a method applicable to all types, sizes and shapes of ordinary soda-lime glassware, it has been necessary to have in mind the difference in the purpose of making the tests from that of testing glass for laboratory use. Mylius, Foerster and Kohlraush[4] offer several methods, but none of them meets with that requirement of simplicity which it was our purpose to attain.

Treatment of Sample

Tests by many investigators have been made on broken samples. The difficulty of obtaining particles of even nearly uniform area and size can easily be seen, and furthermore it is simpler to make the test on the finished article. Such a test involves all factors, surface conditions of the original article as well as composition.

[1] A. E. Williams, "Disintegration of Soda-Lime Glasses," *Jour. Amer. Ceram. Soc.*, **5**, 8 (1922).

[2] *Z. anal. Chem.*, **33**, 381.

[3] "Comparative Tests of Chemical Glassware," by Percy H. Walker and F. W. Smither, Bureau of Standards, *Tech. Paper* **107**. "Chemical Glassware," Percy H. Walker, *Jour. Am. Chem. Soc.*, July, **1905**.

[4] Hovestadt, "Jena Glass," Pages 318–371(Review this work).

Broken fragments treated from 6 to 48 hours in boiling water showed considerable disintegration and flaking on the edges, whereas the surfaces were not always visibly etched or chipped. Also after drying, the edges showed a heavy white fringe as compared to slight dimming of the finished surface. This indicates that there is a distinct difference in the rate of disintegration between fractured surfaces and the original finished surfaces of the article. That there is such a difference seems to be a matter of doubt on the part of Turner[1] and his co-workers and our observations seem not to be quite in agreement with his. On account of such differences in degree of disintegration and because of the fact that the resistance of the finished article is of most importance, all tests were made on unbroken samples.

No attempt to duplicate the work of Mylius,[2] in which he applied the "eosin reaction" to freshly broken surfaces, was made for this same reason. The finished article, whether hand molded or machine molded, is the thing of importance. A study of the disintegration rate of the finished article is necessary in order to discover the extent of all possible factors in their effect upon the resistant properties. Our observations are by no means complete, yet they show certain things of interest and if followed up and applied more extensively may lead to conclusions of much greater value than those so far obtained.

Glass which showed the highest rate of disintegration in such an accelerated test as in boiling water for a period of six hours showed a correspondingly high rate when filled with distilled water and kept at room temperature for a period of six months, so that the six-hour test enables one to ascertain the probability of discoloration or deterioration of the contents of a glass container. The rate of disintegration in boiling water was found, however, to be much higher than in water at a temperature even slightly below boiling. It was also found that by partially filling the container to a mark and keeping it there the titration values obtained were not consistent. It is therefore necessary to expose the entire surface to the boiling water and when this is done results are consistent. It having also been observed that six hours in boiling water produced enough soluble alkaline material to make a quantitative determination practicable even in the case of soda-lime glasses, it was decided that that length of time was sufficient for all purposes.

Preparation and Standardization of Reagents

The titrations were made with 0.01 N H_2SO_4 and 0.01 NaOH. These solutions were prepared by diluting 0.1 N solutions to ten times their

[1] "Examination of Methods Used in Determining the Durability of Glass," W. E. S. Turner, *Jour. Soc. Glass Tech.*, **6** [21], 30 (1922).

[2] "Die Eosinreaktion des Glases an Bruchflachen," *Z. anorg. allgem. Chem.*, **55,** 233 (1907), and **67,** 200 (1910).

original volumes. The 0.1 N NaOH was standardized against fused benzoic acid[1] and the 0.1 N acid was checked against the alkali solution. The alkali solution was kept in Pyrex glass flasks. The indicators used in the method finally adopted were Brom-Thymol-Blue and Phenol-Red. The choice of a suitable indicator was important. Consistent results were not obtained with phenolphthalein, which has a pH range of 8.3 to 10. The 0.02% solutions of the sodium salts of Brom-Thymol-Blue and Phenol-Red were used more or less interchangeably and with equally good results. The pH range of the Brom-Thymol-Blue solution is 6.6 to 8.28 and that of the Phenol-Red 6.6 to 8.2. The point of neutrality being very close to 7.0, it can be seen that both indicators should be suitable. The choice of either one or the other can be left to the analyst, it merely being a choice of color.

Preliminary Treatment

The glass articles were filled with or immersed in (as in the case of tumblers), distilled water at room temperature for a period of 24 hours. They were then rinsed and washed thoroughly and tested immediately.

Methods of Conducting the Six-Hour Boiling Test

(*a*) **Method Used for Tumblers or Small Wide-mouth Articles.**—After the preliminary treatment the article is placed in a two-liter Pyrex beaker, Griffin type, and immersed completely in distilled water to a mark on the beaker. The volume of boiling water is kept constantly at this mark by small additions of water. The addition of a considerable quantity lowers the temperature below boiling and this must be avoided. The beakers are covered over at the top with round bottomed Pyrex flasks partially filled with water. This tends to limit the frequent addition of water and also keeps out dust particles. Blank tests are made on the beakers by repeated boiling for six-hour periods until finally no traces of alkalinity can be obtained.

(*b*) **Method Used for Bottles.**—The bottles are first given the usual preliminary treatment. They are then filled with distilled water at room temperature to a mark such that on increasing the temperature to boiling, they are filled very nearly to the neck. The bottles are then placed upright in a bath of $CaCl_2$ solution (boiling point 103.5 to 104°C) and held in place by a board rack, the latter placed horizontally and close to the surface of the bath. The necks of the bottles project through holes in the rack. A constant volume of boiling water within the bottle is maintained by passing a current of steam through Pyrex capillary tubing into the bottle to offset loss from evaporation. The steam apparatus is so adjusted that

[1] "Benzoic Acid as an Acidimetric Standard," George W. Morey, Bureau of Standards, *Sci. Paper* **183.**

the rate of flow of steam into the bottles is controlled. At the end of six hours the bottles are quickly removed, their contents transferred to Pyrex flasks and titrated.

Methods of Titrating

Several methods were tried. The chief difficulty met with was due to the material in the solution being more or less converted into carbonates. Chemists generally realize the difficulty of titrating dilute carbonate solutions.

The solutions are titrated while hot with the 0.01 *N* acid until colorless, using either Brom-Thymol-Blue or Phenol-Red as indicator. An excess of the acid equal to twice the volume required to destroy the color is then added and the solution is boiled for twenty minutes. This should decompose all carbonates present. The solution is then titrated back to faint alkaline color with the 0.01 *N* NaOH.

In Table I are typical results as obtained by the titrations of solutions from milk bottles after boiling in the manner described above. These bottles came from the same furnace and machine and were made during the same working portion of the day.

TABLE I

No. of bottle	Vol. solution, cc.	Indicator	Total alk. cc. of .01 *N* NaOH	Alkalinity per 100 cc. of sol. Cc. .01 *N* NaOH
1	886	Brom-Thymol-Blue	60.9	6.85
2	880	"	55.5	6.30
3	860	"	60.0	6.98
4	860	Phenol-Red	57.8	6.72
5	848	"	59.8	7.05
6	844	"	57.9	6.85
7	850	"	52.4	6.16

An analysis of the solutions obtained by boiling four tumblers of the same type for 32 hours was made. The four solutions were evaporated to small volumes, combined and titrated. An excess of acid was added, the combined solutions were evaporated and the residue was analyzed. The amount of Na_2O given under "dissolved material" has been corrected for the Na_2O added during titration.

Following are the results obtained:

Analysis of glass		Analysis of dissolved material	
	Per cent	Percentage of total	Gm.
SiO_2	72.10	39.68	0.1090
Na_2O	20.54	57.30	0.1574
CaO	4.28	2.07	0.0057
MgO	2.88	0.19	0.0005
Al_2O_3, Fe_2O_3	0.20	0.77	0.0021
		Total	0.2747 Gm.

Calculating the weights of Na_2O, CaO and MgO to their equivalents in terms of cc. of $N/10$ HCl, a total of 53.09 is given. The actual titration value obtained was 52.1 cc. $N/10$ HCl.

Tests were made on a large number of beverage, catsup and vinegar bottles. These bottles were grouped in pairs, each one of a pair being identical in make, size, shape and tests made. If one of a pair showed a high rate of disintegration during the six-hour test, the other bottle showed a correspondingly high rate when filled with distilled water and stored at room temperature for a period of six months and two of a pair when given the six-hour test invariably gave alkalinity values that checked closely. Some of the results obtained are shown in Table II.

TABLE II

Bottle no.	Alkalinity per 100 cc. 6 hours. Cc. of .01 N NaOH	Alkalinity per 100 cc. 6 months' storage. Cc. .01 N NaOH	Composition of bottle				
			SiO_2	R_2O_3	CaO	MgO	Na_2O
65	8.36	1.97	74.34	0.52	7.02	0.22	17.90
50	4.62	0.90	73.56	1.80	6.58	1.24	16.82
147	3.53	0.49	72.80	1.62	7.90	0.68	17.00
31	1.94	0.14	74.96	1.08	8.07	0.24	15.65
19	5.0	1.20	75.73	0.78	5.18	3.48	14.83
20	6.4	1.48	77.70	1.27	6.23	0.84	13.96

A number of the bottles which were given the six-hour boiling test were analyzed. This number included those which showed the highest rate of disintegration, those most resistant, and some of the "medium" ones. In Table III are given the molecular percentage compositions as calculated from the analyses, the "solubility numbers," which are the number of cubic centimeters of 0.01 N NaOH found present in 100 cc. of the solutions after the test, and two series of numbers calculated from empirical formulas in an attempt to relate composition with resistance to water. The results are arranged in order of the magnitude of the solubility numbers, the first ten having the highest solubility numbers and being therefore the least resistant of all the group, and the last eight being the most resistant and least soluble.

In the formula, $\left(\frac{c-d}{c+d}\right)(c+d-3b)$, c represents the molecular percentage of lime and magnesia, d the molecular percentage of soda and b the alumina. This is the well known Zulkowski formula as modified by Baillie.[1] The formula is mathematically derived, the derivation being

[1] An examination and extension of Zulkowski's theory of the relation between the composition and durability of glasses by William Learmonth Baillie, *Journal Society of Glass Tech.*, **6**, No. 21, May, 1922. (*See next page for balance af footnote.*)

based on the assumption of the presence of simple and complex silicates in the glass. According to Zulkowski's theory a glass is less durable accordingly as the simple silicate content is increased. The complex silicates are not attacked to any extent by water. The above formula therefore represents the molecular percentage of simple silicates. While the experimental work outlined in this paper was not performed with the purpose of verifying any theory, it was seen, however, that the formula is generally in agreement with actual analytical results. The higher the value obtained from this formula, the less durable should be the glass and this was found to be so in most cases. A few variations are noted among the bottles that are of nearly equal resistance, for example, Nos. 6 and 7 are higher than 4 or 5 and Nos. 13, 14, and 21 are much higher than glasses equally resistant.

The mol. percentage of CaO + mol. percentage MgO, bottle No. 1, Table III, = 9.89 mol. percentage of RO. Designating the mol. percentage of SiO_2 (or RO_2), by a, Al_2O_3 by b, RO by c and R_2O by d and substituting these values in the reactivity coefficient, $\frac{c-d}{c+d}(c+d-3b)$, we obtain the negative value, —9.56. The numerical value of this quantity is considered without regard to the sign, that is, glass which as a reactivity coefficient of —9.56 is less durable than glass No. 11 which gives

[1] In applying Baillie's extension of Zulkowski's formula it is always necessary to first compute the molecular percentage composition from the actual percentage composition as obtained directly by analysis. As an illustration, the analysis of bottle No. 1, Table III, gave the following:
SiO_2—69.91%; Al_2O_3—0.91%; CaO—7.04%; MgO—1.56% and Na_2O—20.68%. These percentages are divided by the molecular weights.

69.91	60.3	= 1.1590
0.91	102	= 0.0090
7.04	56	= 0.1257
1.56	40.32	= 0.0387
20.68	62	= 0.3336
	Total	1.6660

$$\frac{1.159 \times 100}{1.666} = 69.57 \text{ mol. per cent } SiO_2$$

$$\frac{0.009 \times 100}{1.666} = .54 \text{ mol. per cent } Al_2O_3$$

$$\frac{0.1257 \times 100}{1.666} = 7.55 \text{ mol. per cent CaO}$$

$$\frac{0.0387 \times 100}{1.666} = 2.34 \text{ mol. per cent MgO}$$

$$\frac{0.0387 \times 100}{1.666} = 20.00 \text{ mol. per cent } Na_2O$$

a value of —5.21. This particular formula is applicable only in case $c + d$ is greater than $3b$, which is usually the case in commercial glassware.

The second formula, $\frac{d}{b+c}$, which represents

$$\frac{\text{Mol. percentage of } Na_2O}{\text{Mol. percentage of CaO and MgO + mol. percentage of } Al_2O_3}$$

is not based on any theory. It is interesting to note that here also are certain exceptions and that these correspond to the same exceptions as cal-

TABLE III

	Bottle no.	Cc. of .01 N NaOH per 100 cc. solution. Solubility no.	RO_2 (a)	R_2O_3 (b)	RO (c)	R_2O (d)	$\frac{c-d}{c+d}(c+d-3b)$	$\frac{d}{b+c}$
Group I	1	12.02	69.57	0.54	9.89	20.00	— 9.56	1.92
	2	8.71	72.18	0.92	7.97	18.95	— 9.88	2.13
	3	8.44	71.82	0.56	9.55	18.12	— 8.05	1.79
	4	8.40	73.45	0.60	7.85	18.10	— 9.54	2.142
	5	8.36	74.40	0.31	7.80	17.50	— 9.34	2.158
	6	8.35	74.44	0.26	7.30	18.03	—10.39	2.382
	7	8.12	69.97	0.94	8.64	20.45	—10.64	2.133
	8	7.20	73.92	0.39	8.40	17.29	— 8.47	1.967
	9	7.14	69.16	1.04	9.63	20.15	— 9.42	1.89
	10	6.81	72.90	0.46	8.70	17.94	— 8.42	1.958
Group II	11	6.33	77.67	0.75	7.88	13.70	— 5.21	1.588
	12	5.67	70.87	1.10	10.52	15.51	— 4.33	1.335
	13	5.50	71.43	0.96	9.00	18.57	— 8.57	1.865
	14	5.20	75.06	0.23	8.11	16.56	— 8.22	1.99
	15	4.90	73.52	1.09	8.95	16.44	— 6.48	1.637
	16	4.10	72.92	0.78	9.54	16.71	— 6.53	1.61
	17	4.10	75.94	0.48	8.52	15.04	— 6.12	1.67
	18	3.50	73.00	0.97	9.25	16.78	— 6.58	1.642
	19	3.50	75.69	0.62	8.33	15.37	— 6.07	1.717
	20	3.20	72.35	0.60	9.67	17.37	— 7.19	1.691
	21	3.20	71.52	1.00	8.86	18.61	— 8.67	1.888
Group III	22	2.86	69.46	0.67	12.38	17.49	— 4.77	1.340
	23	2.85	72.29	0.60	10.12	16.99	— 6.41	1.584
	24	2.27	74.10	0.51	10.31	15.08	— 4.48	1.394
	25	1.98	71.90	0.73	11.27	16.10	— 4.44	1.342
	26	1.96	75.12	0.64	8.96	15.28	— 5.82	1.592
	27	1.91	73.25	0.30	10.40	16.05	— 5.38	1.500
	28	1.51	73.37	1.47	9.39	15.77	— 5.27	1.452
	29	1.41	69.11	0.84	12.49	17.55	— 4.63	1.316

culated from Zulkowski's formula. Here also Nos. 6, 7, 13, 14 and 21 are out of order as related to their resistance numbers. It seems likely that factors other than composition influence the rate of disintegration, although

to a less extent. Such a factor might be surface condition, a smooth surface being more resistant than a rougher one in the case, for example, of two bottles of the same composition.

From a consideration of Table III the following is evident: All members of Group I have distinctly higher reactivity coefficients and solubility numbers than any other members of Group III. With three exceptions (Nos. 13, 14 and 21) the same holds in comparing members of Group I with the medium class, II. All glasses which have a solubility number greater than 6.5 have a reactivity coefficient greater than 8 and, with the three exceptions mentioned, all glasses having a solubility number less than 6.5 have a reactivity coefficient of less than 8. Glass having a solubility number not greater than 3 is of excellent quality as regards its resistant properties. This type of glass usually has a reactivity coefficient of less than 6.5. The ratio of the molecular percentage of R_2O to the combined mol. percentage of RO and R_2O_3 as computed, tends to show that the most resistant glass in the table gives for such values less than 1.5 and for glass in Group I, which is least resistant, values greater than 1.8. In Group II, or the medium class, with three exceptions, the values obtained by this second formula are between 1.6 and 1.7.

The value of using this second formula might be questioned. The lime to soda molecular ratio has been mentioned by various authors. It is usually considered that alumina adds to durability to a greater extent than lime and is often referred to as "glorified lime." The author has introduced this formula simply because of the fact that it is noticed that the magnitude of the values obtained by it is generally, though not always, of the same order as that of the numerical values as obtained by the reactivity coefficient.

The interior surface areas of four of these bottles were measured. This number included those which differed most in size and shape and were the most extreme cases of dissimilarity among the whole number (about 200) that were tested. If the resistance of the bottles had been calculated in terms of unit area instead of concentration per unit volume, the same comparable results would have been obtained throughout. Following are the inside area measurements of the four bottles, their volumes and alkalinity values expressed both in terms of concentration per unit volume and dissolved from 100 cm.² of surface.

Bottle no.	Area, cm.²	Volume, cc.	Cc. of 0.01 *N* alk. per 100 cc. sol.	Cc. of 0.01 *N* alk. dissolved from 100 cm.²
58	274.94	344	4.62	5.81
39	308.83	360	5.22	6.10
173	628.18	806	7.25	9.30
167	570.7	800	4.55	6.37

The numbers of the fourth column bear to one another nearly the same ratio as do the numbers of the fifth. There was seldom a case among a

large number tested where the differences of such ratios equalled ten per cent. The greatest discrepancies are apt to occur among smaller bottles, but these may be tested in large beakers as in the case of tumblers. The above figures indicate that bottles may be tested on a basis of capacity and that such a basis should put them in their proper class whether of high, low or medium resistance.

Summary

The resistance to water of various types of soda-lime glasses has been studied.

A method of measuring this rate is suggested, which is simple and accurate and applicable to glass surfaces.

The relation of composition to resistance to water of various American bottles has been studied. It was found that these bottles varied considerably in resistance to water.

Two unrelated formulas applied to analytical data are in general agreement and indicate the importance of composition as a factor in the making of the most durable glass. Glass which gives a solubility number less than 5.5 after a six-hour test has sufficient resistant qualities for most purposes.

It has been found that with respect to composition, the actual analysis having been computed to molecular percentage composition, the "reactivity coefficient," as calculated, should be less than 8 for fairly resistant glass. If this reactivity coefficient is less than 6, the glass is of excellent quality and very resistant. It is to be understood that this is generally but not invariably the case, as factors other than composition are also involved, although to a less extent, in making glass of a resistant quality.

THE ACTION OF SLAG UPON SILICA, MAGNESITE, CHROME, DIASPORE AND FIRE-CLAY REFRACTORIES

By R. M. Howe, S. M. Phelps and R. F. Ferguson[1]

ABSTRACT

The resistance of magnesite, chrome, silica, diaspore and fire-clay brick to the action of five slags was studied by a new method. The brick and slag were reduced to a powder, mixed in several proportions, and the fusion points of the mixtures determined. The actual melting points of the mixtures, the porosity of the brick, and the depression of the fusion point of the refractory due to slag action are taken into consideration in interpreting the results. Magnesite had a slightly higher resistance to the action of most slags than did chrome. The behavior of silica brick varied considerably with different slags. The behavior of different types of fire-clay brick showed considerable variation, depending upon the nature of the slag, the composition of the brick, and its density.

In a previous paper[2] it was demonstrated that the action of slag on refractories is the resultant of two tendencies—penetration and solution. Experimental data were also presented to show "that a slag penetration test is of slight practical value, for its results may be obscured by a high or low resistance to solvent action." Other plant and laboratory data led to the statement that "a test designed to show resistance to chemical action should give information of practical value." Since the presentation of that paper it has been possible to make a number of tests by means of this latter method.

This test is based upon the principle that slags react with refractories forming mixtures or compounds with lower fusion points. The depression of the fusion point of the refractory due to this action is regarded as a measure of the intensity of the action. The actual fusion point gives an idea of the limit of safety when the refractory brick are in contact with molten slag.

Magnesite, chrome, silica, diaspore, and five kinds of first-quality fire-clay brick were compared. They were each exposed to the action of basic open hearth, acid open hearth, heating furnace, blast furnace, and coal ash slags.

Method of Procedure

Ten pounds of each sample of refractory brick was first reduced to the same state of subdivision. This precaution was taken in order to overcome any possible difference in resistance to slag that might arise from a variation in the fineness of the materials. A typical screen analysis of the prepared samples is given on following page.

[1] Industrial Fellows of the Mellon Institute of Industrial Research, University of Pittsburgh, Pittsburgh, Pa.

[2] "A Study of the Slag Test," *Jour. Amer. Ceram. Soc.*, **6** [2], 466–473 (1923).

80 to 100 mesh.....	38.0%
100 to 120 mesh.....	13.5%
120 to 140 mesh.....	4.5%
140 to 160 mesh.....	4.5%
160 to 180 mesh.....	8.0%
Through 180 mesh.....	31.5%
	100.0%

Batches were then made that contained 4, 8, 12, 16, 20, 30, 40 and 50 per cent of several kinds of slag mixed with the refractory materials. These batches were made into test cones. The fusion point of each cone was then determined and the results were recorded.

It was found necessary, in making these determinations, to set the clay, silica, and standard Orton cones in fire-clay pats. The magnesite cones were set in magnesite pats and the chrome cones in chrome pats. In the latter cases the round cone pat was divided into two sections, one for the Orton cones and the other for the test cones. This necessity arose from the fact that the magnesite, chrome, slag mixtures reacted with the fire-clay base and gave results from 2 to 16 cones too low. Each fusion point determination was extended over a period of four hours, this slow schedule having been adopted to allow the more complete action of the slag.

Experimental Data

The chemical composition and fusion point of each refractory brick is given in Table I. The analysis and fusion point of each slag is given in Table II. The fusion point of each mixture is given in Tables III, IV, V, VI, and VII. An "x" in the fusion point tables indicates that this material or mixture fused above cone 36, the limit of the gas furnace in which these determinations were made.

TABLE I

ANALYSES AND FUSION POINTS OF REFRACTORY MATERIALS

Nature of brick laboratory letter	Diaspore B	Diaspore E	Fire clay A	Fire clay E	D	C	Silica L	Magnesia H	Chrome I
Silica	30.98	47.94	50.98	57.12	62.20	80.06	96.58	7.80	12.94
Alumina	63.20	47.13	43.94	38.01	33.44	18.30	.74	2.42	23.17
Ferric Oxide	2.62	1.20	3.16	1.94	1.79	.88	.50	3.62	13.45
Titania	3.32	2.15	...	1.97	1.79	1.34	...	.00	.00
Lime	.21	.73	.36	.44	.38	.20	1.88	3.86	.07
Magnesia	trace	.11	.52	.50	.25	.07	.16	82.40	8.95
Alkalies	.46	1.23	1.32	.16	.50	trace	.21	trace	.03
Chromic Oxide	...	...	...	...	...	...	...	...	41.24
Total	100.79	100.49	100.28	100.14	100.35	100.85	100.07	100.10	99.85
Fusion Point in Cones	36	33½	32½	32½	30½	28	31½	...	...

TABLE II

ANALYSES OF SLAGS USED IN TESTS

Slag	Basic open hearth	Blast furnace	Heating furnace	Acid open hearth	Coal ash
Silica	23.32	36.82	16.98	50.16	56.76
Alumina	0.30	11.70	3.91	3.00	28.59
Iron Oxide	26.60	3.40	75.30	30.25	9.25
Titania	1.02	0.54	0.70	1.54	1.40
Lime	37.95	43.40	0.79	2.32	1.57
Magnesia	6.96	2.47	0.14	0.93	0.45
Manganese Dioxide	4.24	0.89	1.89	11.72	trace
Alkalies	0.09	0.57	0.06	trace	1.34
Total	100.48	99.79	99.77	99.92	99.36
Fusion Point	Cone 7	Cone 3	Cone 2	Cone 12	Cone 8

TABLE III

FUSION POINTS OF ACID OPEN HEARTH SLAG—REFRACTORY BRICK MIXES*

Brick designation	Per cent slag in mixture 0	4	8	12	16	20	30	40	50
Diaspore B	36	35	33.5	33	33	30.5	26	20	13
Fire Clay K	33.5	33	31.5	30	29	27	16	14	9
Fire Clay A	32.5	32.5	32	30.5	28	26	13	11	8
Fire Clay E	32.5	32	29	26	20	16	14	11	9
Fire Clay D	30.5	29.5	20	17	15	13	10	8	6
Fire Clay C	28	27	20	18	17	16	13	8	6
Silica L	31.5	31.5	31.5	31	31	29	28.5	28	28
Magnesite H	..	..	..	..	36	33	32	31	27
Chrome I	..	36	33.5	31.5	30	20–26	15	13	12

* The diaspore and fire-clay brick are arranged in order of increasing silica content.

TABLE IV

FUSION POINTS OF BLAST FURNACE SLAG—REFRACTORY BRICK MIXES*

Brick designation	Per cent slag in mixture 0	4	8	12	16	20	30	40	50
Diaspore B	36	33.5	32.5	29	20	14.5	14	14	10
Fire Clay K	33.5	32.5	31	26	18	14	13.5	13.5	12
Fire Clay A	32.5	30	29	20	17	13.5	13	12.5	9
Fire Clay E	32.5	29	29	17.5	13.5	13	13	12.5	11
Fire Clay D	30.5	26	20	13.5	11.5	11	9	7	5
Fire Clay C	28	20	14	13	10	8	5	2	2
Silica L	31.5	31	31	30.5	30	27	17	6	3
Magnesite H	..	..	..	..	36	33.5	26	17	14
Chrome I	..	..	..	35	34	32	16	9	8

* The diaspore and fire-clay brick are arranged in order of increasing silica content.

TABLE V

FUSION POINTS OF BASIC OPEN HEARTH SLAG—REFRACTORY BRICK MIXES*

Brick designation	Per cent slag in mixture 0	4	8	12	16	20	30	40	50
Diaspore B	36	33.5	32.5	20–26	14	12	11	10.5	10
Fire Clay K	33.5	32	30.5	18.5	14.5	14	12	8	6
Fire Clay A	32.5	30.5	26	16	15	13	9	8	5
Fire Clay E	32.5	30.5	26	13	11.5	10.5	7	6	2
Fire Clay D	30.5	28	17	11.5	11.5	10	9	2.5	2
Fire Clay C	28	20	14.5	12	11	8	3	2	1
Silica L	31.5	31.5	31.5	31	31	30	19.5	16	4
Magnesite H	..	..	..	..	..	..	..	..	..
Chrome I	..	..	..	..	..	..	..	..	..

* The diaspore and fire-clay brick are arranged in order of increasing silica content.

TABLE VI

FUSION POINTS OF HEATING FURNACE SLAG (FUSION POINT = CONE 2)—REFRACTORY BRICK MIXES*

Brick designation	Per cent slag in mixture 0	4	8	12	16	20	30	40	50
Diaspore B	36	34	32.5	31.5	29.5	20	15	11	9
Fire Clay K	33.5	32.5	31.5	30	28	19	14	10	9
Fire Clay A	32.5	31+	30	26	19	18	10	9	8
Fire Clay E	32.5	31+	29	26	18	16	11	8	8
Fire Clay D	30.5	28	18	13	11	10	9	8	8
Fire Clay C	28	20–26	17	15	14	13	12	11	10
Silica L	31.5	30.5	29.5	28.5	28.5	28.5	28	27	26
Magnesite H	..	..	..	..	..	..	..	..	..
Chrome I	..	..	..	..	..	36	35	36	36

* The diaspore and fire-clay brick are arranged in order of increasing silica content.

TABLE VII

FUSION POINTS OF COAL ASH SLAG—REFRACTORY BRICK MIXES*

Brick designation	Per cent slag in mixture 0	4	8	12	16	20	30	40	50
Diaspore B	36	35.5	35	34.5	34	33.5	33	32.53	30.5
Fire Clay K	33.5	33+	33	33	32.5	32.5	32	30.51	30
Fire Clay A	32.5	32	32	31.5	31.5	31.0	30.5	29	20–26
Fire Clay E	32.5	32	31.5	31.5	31.5	31.0	31	28	26
Fire Clay D	30.5	30.5	30	28	27.5	27	26.5	19	15
Fire Clay C	28	28—	27.5	27.5	27	26.5	20–26	18.5	16

* The diaspore and fire-clay brick are arranged in order of increasing silica content.

Discussion of Results

The data obtained were plotted in several ways in order to simplify their study, but the arrangement shown in Figures 1–4 proved to be the most effective. In plotting these curves the silica contents of the diaspore, fire clay, and silica brick were taken as the abscissae. The fusion points

of each brick, with or without slag, were taken as the ordinates. The points representing equal slag concentrations were then connected.

When the resulting curves are examined, it is evident that a given slag does not exert the same influence upon every brick. Eight per cent of basic open-hearth slag, for example, lowers the fusion point of fire brick K 3 cones, of fire brick D $13^1/_2$ cones, and of silica brick L only $^1/_2$ cone. Increasing amounts of a given slag also exert a greater influence, as is shown in the action of basic open-hearth slag upon fire brick C. Four per cent of this slag lowers the refractoriness of the brick 8 cones, 8 per cent $13^1/_2$ cones, 12 per cent 16 cones, 20 per cent 20 cones, and 50 per cent 27 cones. It is to be noted also that different slags do not exert the same influence upon any given brick. The fusion point of brick K is decreased $16^1/_2$ cones by the action of 30 per cent of acid open-hearth slag, and from $1^1/_2$ to $21^1/_2$ cones by equal amounts of the other slags.

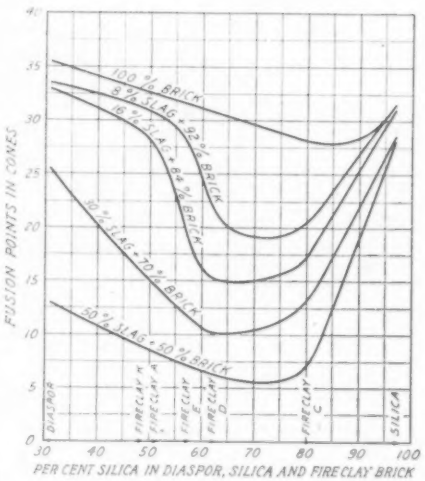

FUSION POINTS IN CONES
100 % BRICK
8 % SLAG + 92 % BRICK
16 % SLAG + 84 % BRICK
30 % SLAG + 70 % BRICK
50 % SLAG + 50 % BRICK
DIASPOR
FIRECLAY K
FIRECLAY A
FIRECLAY E
FIRECLAY D
FIRECLAY C
SILICA
PER CENT SILICA IN DIASPOR, SILICA AND FIRECLAY BRICK

FIG. 1.—Fusion points of diaspore, silica and fire-clay brick mixed with acid open-hearth slag.

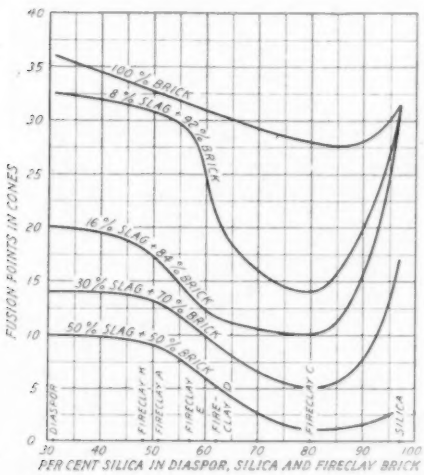

FUSION POINTS IN CONES
100 % BRICK
8 % SLAG + 92 % BRICK
16 % SLAG + 84 % BRICK
30 % SLAG + 70 % BRICK
50 % SLAG + 50 % BRICK
DIASPOR
FIRECLAY K
FIRECLAY A
FIRECLAY E
FIRE-CLAY D
FIRECLAY C
SILICA
PER CENT SILICA IN DIASPOR, SILICA AND FIRECLAY BRICK

FIG. 2.—Fusion points of diaspore, silica, and fire-clay brick mixed with blast furnace slag.

Thus the behavior of the slags in the test agrees with that which has been observed in service in three general but important details.

1. The intensity of the action increases with the slag concentration.

2. Different slags do not exert the same influence upon any one material.

3. The influence of a given slag varies with different refractory materials.

These facts show that it is possible to distinguish between the action of different slags upon refractories by laboratory methods. They also show that the brick which are least affected in this test show a high

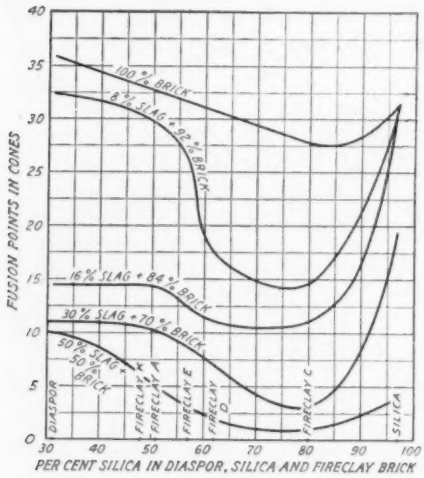

FUSION POINTS IN CONES
PER CENT SILICA IN DIASPOR, SILICA AND FIRECLAY BRICK
100 % BRICK
8 % SLAG + 92 % BRICK
16 % SLAG + 84 % BRICK
30 % SLAG + 70 % BRICK
50 % SLAG + 50 % BRICK
DIASPOR
FIRECLAY K
FIRECLAY A
FIRECLAY E
FIRECLAY D
FIRECLAY C
SILICA

FIG. 3.—Fusion points of diaspore, silica, and fire-clay brick mixed with basic open hearth slag.

better service. This is due to the fact that the slag action is restricted to a smaller area in the case of the denser brick.

The test described does not take this fact into consideration, for the influence of density and of the texture of the particles is destroyed in the preparation of the sample. It is believed, however, that allowance can, to a certain extent, be made for this condition by taking into consideration the probable slag absorption of different brick.

Silica brick will not absorb more than about 20 per cent of this same slag. Consequently, they should always offer a higher resistance to the action of this slag than fire-clay resistance to the slags to which they are exposed in service. Consequently, the use of this method as a means of studying slag action is justified. At the same time there are conditions where this test, like most others, may lead to erroneous conclusions if the results are improperly interpreted.

Slag action has been subdivided into two steps: penetration and solution.[1] Of these, solution is often the more important, for the penetration of several brick may be the same. At the same time, conditions exist where two brick differ more in resistance to penetration than in resistance to solution, and in those cases the denser brick may give the

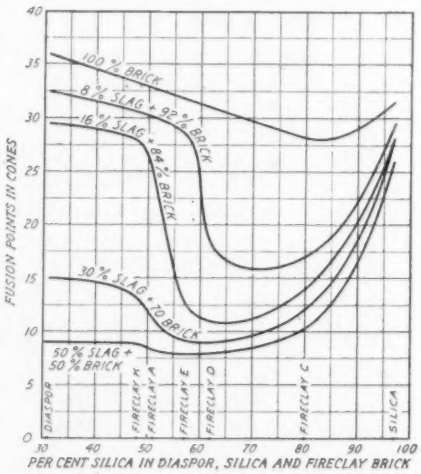


FIG. 4.—Fusion points of diaspore, silica, and fire-clay brick mixed with heating furnace slag.

[1] Penetration refers to the physical process by which a liquid enters the pores of a solid material. The word solution is used in a broad sense and includes the dissolving of solids, liquids, and gases by solid or liquid materials. In this broad sense the term solution applies to the action between lime and silica brick in a lime kiln, as well as to the action of a slag upon the exposed end of a fire brick.

brick C. This conclusion is based upon the fact that a mixture containing 20 per cent of this slag and 80 per cent of silica brick is more refractory than fire-clay brick C, although it is free from slag. Silica brick also possess an advantage over fire-clay brick A and E with this particular slag, although this advantage might be overcome by making the latter sufficiently dense to prevent appreciable slag absorption.

Fire-clay brick K possess an advantage over fire-clay brick A and E, but this might be lost due to slight differences in density.

The writers believe that reasoning of this kind must be applied in the interpretation of these slag test results. While burn is an important factor, there is no reason to believe that its influence will be altered under the conditions of the test.

Other outstanding features of the results are as follows:

1. Magnesite and chrome brick showed a particularly high resistance to the action of basic open-hearth slag, as they do in actual service.

2. Brick made from diaspore were but slightly affected by the action of these slags. They are often used where slag action is unusually severe.

3. Silica brick showed a high resistance to the action of acid open-hearth and heating furnace slags, both of which are composed almost entirely of silica and iron oxide. They showed a low resistance to the action of basic open-hearth and blast furnace slags, two slags that are high in lime.

4. The behavior of the fire-clay brick differed considerably as it does in service. With the particular slags used in the investigation, high alumina appeared to be an advantage. The advantage was not the same, however, in all cases. Other slags may be expected to favor brick high in silica, as has been demonstrated in service. Certain coal ashes, for example, are said to attack brick high in alumina more readily than those which are high in silica. The same is true of slags encountered in the metallurgical industries.

In conclusion, the writers wish to acknowledge the valuable assistance of W. R. Kerr, W. M. Walker, and Foster Robertson in making the various determinations.

METALLURGICAL REQUIREMENTS OF REFRACTORIES FOR FURNACES MELTING COPPER ALLOYS

By H. W. Gillett

ABSTRACT

The requirements for refractories for pit furnaces are less severe than for those for open-flame or electric furnaces. Suitable refractories for electric furnaces will meet the needs of the other types as well. Attention is therefore directed to the development of better refractories for electric furnaces melting non-ferrous alloys. The most important types of electric brass furnaces are described in relation to their refractory problems. The requirements vary with the type of furnace. All types require refractories that will resist penetration by metal, will not spall or crack, have low thermal conductivity and high mechanical strength at working temperatures.

A refractory combining these properties in sufficient degree would be welcomed by users of copper-alloy furnaces, especially electric furnaces, and a rather high price would not be an insurmountable barrier to its use if it will markedly increase the lining life.

Commercial copper alloys contain from 50% copper up, the common alloying elements being zinc, tin and lead. Nickel, aluminum or iron enter such alloys more rarely. Since yellow brass and the red brasses are the most common alloys, the furnaces for melting these alloys are typical of those used for all the copper alloys.

These alloys are all poured at from 1000° to 1300°C. Hence as far as mere temperature goes the requirements are not severe.

The alloys are melted in a variety of furnaces. When crucible furnaces are used, the refractories do not come in contact with the metal.

In a natural draft coal- or coke-fired furnace, the refractories must not flux readily with the fuel ash, and should be strong enough to stand barring off clinkers without cracking away. Few brass furnaces of any type are run 24 hours a day so the refractories must not spall badly on heating or cooling.

Moderate thermal resistivity is desirable, but the heat losses in the flue gases of a coke furnace are so great anyhow that production is not greatly speeded up by the small saving of heat obtained by better thermal insulation.

These pit fires were used in the earliest history of the brass industry and did not change much for a hundred years.

When more rapid production was desired, forced draft began to be used, giving higher furnace temperatures and slightly more severe conditions to be met by the refractories. Forced draft furnaces are, however, not very common. The furnaces using solid fuels are generally lined with a fairly refractory fire brick about 4½" thick. Circle brick is generally used, though square furnaces using standard brick are common. These furnaces, in the usual sizes, generally produce 100,000 to 400,000 lbs. of metal before relining is done.

The furnaces are relined when the lining has worn down so thin that the fuel space is too great and fuel is therefore wasted. The life can be greatly prolonged by thorough patching at least once a week. Several refractory mixtures that can be applied hot are on the market.

Crucible furnaces fired by oil, less commonly gas, do not have to contend with clinkers or with fluxing with ash, and are still usable even after the lining has worn away considerably. Hence these show, on the average, a higher production between relinings, 200,000 to 800,000 lbs. being common.

On the other hand, in a poorly designed oil or gas furnace with the burner so placed that the flame impinges directly on the lining, the life may be low. By placing the burner in a side chamber or having the burner enter at an angle so that the flame swirls about the crucible, better lives are obtained.

Circle fire brick are the common linings for these furnaces, although rammed up carborundum linings are used to some extent. They give a longer life, but reduce the thermal efficiency somewhat. Patching with carborundum and washing the surface with carborundum cement is often advised.

Furnaces from which the crucible is lifted to pour seldom take over 400 lbs. per charge and 200 to 300 lbs. is the normal size. Tilting crucible furnaces, from which the metal is poured into a ladle, run up to 400 lbs. or more in normal sizes, but in any crucible furnace the fragility of the crucible keeps the capacity per heat down.

For furnaces of larger capacity we have to go to the hearth-type furnace. Now and then one finds a coal- or oil-fired tapping reverberatory, but these are very rare, coal-fired furnaces being still more rare than oil-fired. Tilting, open-flame oil furnaces are the chief fuel-fired hearth-type furnace. A few open-flame furnaces fired with natural gas are used in favored localities.

In the hearth-type furnaces the hearth has to be metal-tight and instead of the separate, easily replaceable cover of the crucible furnaces, the domed roof of the open-flame furnace is an integral part of the lining. Since the heat is more directly applied to the charge, the refractories of the open-flame are not heated quite as hot as those of the crucible furnaces where the heat must be driven through the walls of the crucible. The better application of heat in the open flame furnace makes it possible to get rapid production and slight variations in thermal efficiency are of more practical importance than in the crucible type, so the lining of the open-flame furnace is generally thicker than in the crucible types.

In a crucible the metal, with its usual charcoal covering, is pretty well protected from the gases of combustion, nor do these gases sweep over a large area of metal. But in the open-flame furnace, with its wide, shallow bath, on which it is difficult to maintain a charcoal covering, the gases

have ready access to the metal. This means that oxidation must be guarded against and that the volatile metal, zinc, is readily swept out by the gases. The first point makes it difficult, though not at all impossible, to produce alloys of the highest quality in open-flame furnaces, but the second makes it entirely impractical to melt alloys high in zinc in such furnaces.

There are several forms of open-flame furnace. One is of approximately spherical shape, built up of special shapes of fire brick. Another is rectangular, of standard brick with suitable arched roof. Still others are horizontal cylinders or ovoids, and may be lined with circle brick or with rammed-up linings. Carborundum fire sand is widely used in the rammed-up linings, but it is quite a trick to ram up such a lining and have the roof portion stay in place.

The necessity for metal-tightness in the hearth requires that brick shall not be too porous, shall have true faces so that they can be laid closely without too much cement, and shall not crack or spall readily to form pockets into which metal can run, contaminating the next heat if of a different composition, or damaging the lining if allowed to freeze. A rammed-in layer of carborundum fire sand and fire clay, fire clay and ganister, or some other plastic mixture is usually put over the bricks in the hearth. If leaded alloys, even those not very high in lead, are melted, the lead is very likely to segregate to the bottom of the melt and seep into the hearth.

The hearth must have considerable strength because ingots or heavy pieces of scrap may be thrown in, or, in case of mechanical charging, dumped in. Where borings enter into the charge a layer of these charged first will protect the hearth a good deal.

In ordinary melting in open-flame furnaces no slag is carried, though when handling gates to which molding sand adheres, a lime slag, sometimes with a little fluorspar, may be used. To avoid this the gates are sometimes cleaned in a tumbler. Glass or borax may be used, but this is rarely done, so that in general the hearth has to withstand only the fluxing action of a little adhering sand. When phosphor bronze is melted small amounts of P_2O_5 may be produced which has a strong fluxing action.

The hearth must introduce no detrimental impurities into the charge. Conditions within the furnace are held as reducing as is compatible with fuel efficiency and there is a possibility of reduction of some metal such as silicon from the hearth. However, this is of real importance only when handling aluminum bronze, in which case the material of the hearth must be of materials not reduced by aluminum at the temperature used.

In the operation of an open-flame furnace the flame is usually held long enough so that it burns beyond the spout, so that the flame plays directly on the refractories about the spout. The spout needs frequent patching, but this is not difficult as the spout is accessible.

The body of the lining is none too accessible and open-flame furnaces therefore may not be given as thorough patching as they really need. The attention paid to patching and the quality of workmanship in putting in the lining have a great deal to do with its life.

Open-flame furnaces are very seldom used in capacities below 500 lbs. The average capacity is around 1000 lbs. while one ton furnaces are common and a few are in use up to 5 tons.

Open-flame furnace linings in general produce around 1,000,000 lbs. before complete relining is necessary and runs of 2,000,000 to 3,000,000 are not uncommon. On the other hand, some of the rammed-up linings may give only 100,000.

The desirability of more perfect control of temperature, avoidance of oxidizing conditions, of fuel storage, the necessity for more rapid and cheaper production of alloys high in zinc, *i. e.*, of furnaces of larger capacity than the crucible type of fuel-fired furnaces required by those alloys, the desirability of making the work of the furnace tenders less hot and arduous, and the need for furnaces involving lower losses of metal in melting, all tended to bring about the introduction of the electric furnace for melting brass and other copper alloys.

The first electric brass furnace in commercial operation started up seven years ago and there are now well over 400 in use. The American Brass Co. has over 80 electric brass furnaces and the brass rolling mill industry as a whole does the great majority of its melting electrically. The foundries as well as the rolling mills have taken up electric melting, the Ford Motor Car Co., for example, using 8 one-ton furnaces.

Electric brass furnaces will ultimately melt not far from 90% of the country's output. Hence the problem of refractories for electric brass furnaces is rapidly becoming even more important than that of refractories for fuel-fired brass furnaces.

Electric furnaces used for copper alloys are very different from the direct arc electric furnaces used for steel melting. Disregarding a few types which have only slight use, there are three general types of electric furnace widely used on brass, each of which has its own special refractory. These are the Baily, a reflected-heat type used mainly by foundries, very little by rolling mills, the rocking indirect arc type, used by both foundries and rolling mills, and the Ajax induction furnace, used chiefly by rolling mills.

There are some points on which all three types have similar problems. All are hearth type furnaces and the general requirements stated for refractories for open-flame furnaces apply. Thermal efficiency is of great importance on account of the cost of electric heat, so the electric furnace linings must be designed to minimize heat loss. The electrical conductivity of the refractories at operating temperatures has to be taken into account.

Brief descriptions of the three main types will have to be given in order to make intelligible the special requirements they impose on their refractories.

The Baily furnace (see Figs. 1 and 2) is heated by a granular carbon resistor held in a trough made of carborundum.

That the carborundum of the trough is a fair electrical conductor is an advantage, because the trough carries part of the current and produces part of the heat, thus reducing the required current density in the granular carbon resistor and giving more even heating. The trough is supported on piers, the part of the pier directly supporting the trough usually being silica brick, and is situated above the charge and placed away from the walls so as to allow free radiation. The piers must not be too good electrical conductors, else the current would tend to short-circuit down to and through the metal bath. The lining is of high grade fire brick, usually a highly aluminous brick such as Corundite, backed up by Silocel powder. The hearth is tamped up of carborundum fire-sand, fire clay and water-glass, and is sometimes placed in an iron pan to check penetration of the metal.

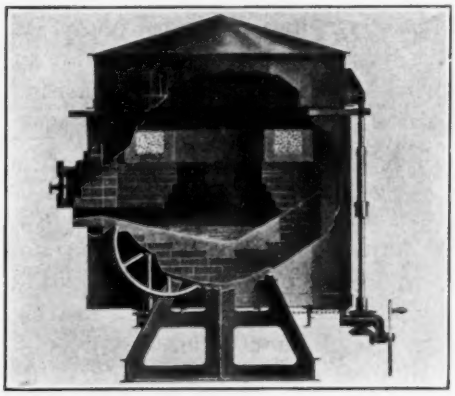


FIG. 1.—Cross-section of a Baily electric furnace showing trough forming the resistor element, hearth, and pouring spout.

In the early days the trough was rammed up about a wooden form and baked in place. It was soon found necessary to build the trough of sections made like a regular carborundum brick. The trough is still the weakest point of the refractories of this furnace. In order to heat the charge at a rapid enough rate to get any production, the interior of the granular resistor itself must run hot, probably at about 1800°C. A granular resistor is prone to develop hot spots, and the leeway between the operating temperature of the resistor and the point at which the trough will fail is not very great. The whole furnace design is built around the requirements of the trough. In order to provide free radiation from the trough there is a good deal of waste space in the furnace, making the furnace big for its capacity, and involving large wall losses and high heat storage.

The furnace, in a size rated to contain 1500 lbs. and usually run with perhaps 1200, is only operated at around 100 kw. or less, a very low rate of power input for a furnace of the size. A higher rate of power input would greatly increase the output and the efficiency and lower the melting

cost in this type of furnace. But attempting to raise the power input too soon breaks down the trough and puts the furnace out of commission. The furnace is often provided with a pyrometer in the roof which gives a check against overheating. The pyrometer does not tell anything as to the temperature of the charge, and it is not needed as far as the maintenance of the roof itself goes, but merely shows indirectly whether dangerous temperatures are being reached in the trough.

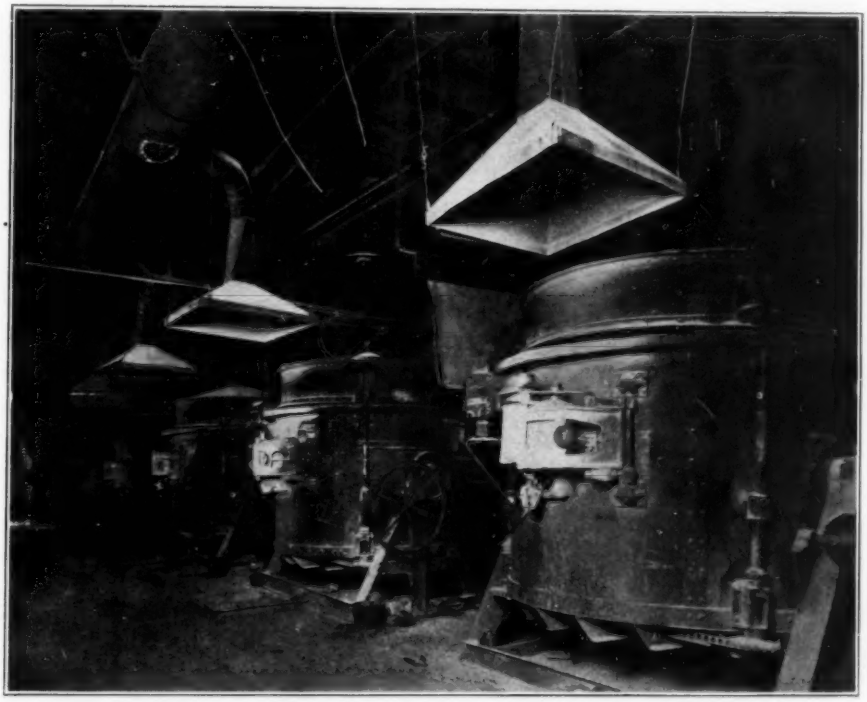


FIG. 2 —Baily electric brass furnaces.

In general the furnace produces somewhere around 250,000 to 1,000,000 lbs. before the trough needs replacement with, say 750,000, as the average. The piers and hearth are repaired or replaced at the same time. The brick linings should outlast several troughs.

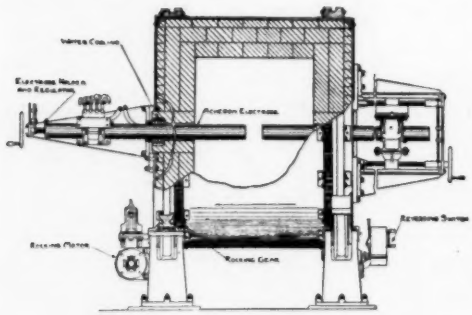
While the makers of this furnace express themselves as considering the refractories entirely satisfactory, it is obvious that a resistor trough more refractory than carborundum, and not readily oxidizable by air entering when the furnace is opened, would allow the use of a higher power input. This would increase the daily production, which in this furnace is relatively low, decrease interest charges and lower the melting cost.

Some other furnaces of the same general type, in that the heat is largely sent to the charge by reflection from the walls and roof, have been brought out, in which the trough is either entirely avoided or the design so planned that some damage to the container or the resistor does not put the furnace out of business, but these types usually gain this advantage at the expense of some other advantage.

The next type, the moving indirect arc type, is not hampered by trough limitations and operates at a much higher rate of power input, the limit of the rate being safety to the lining. The 500 lb. size of this type takes 75 to 125 kw. and the one ton size 300 kw.

Half a dozen forms of the moving indirect arc furnace have been developed in this country and a couple of forms are being developed in Germany and one in England.

The rocking furnace made by the Detroit Electric Furnace Co., which is licensed to operate under the Bureau of Mines patents on this type of furnace, is the main form of this type. This is shown in Figs. 3 and 4. An arc plays between the electrodes, heating the charge and the furnace walls. When the metal is melted, the furnace rocks back and forth so that all the circumference of the lining save only that section occupied by charging door and pouring spout is washed by the metal. This takes up the heat stored in the walls and brings them down to the temperature of the metal.



Detroit Furnace—Sectional View

FIG. 3.

The end walls are not washed, but are somewhat shielded from the arc by the electrodes. The rocking also mixes the metal so that the surface does not become overheated, thus making it possible to operate on alloys high in zinc.

Since the whole furnace lining is the hearth at one time or another in the rocking cycle, metal-tightness of the lining is important. In melting a leaded bronze containing over 25% lead, over 100 lbs. of lead went into the hearth on the first heat in a one-ton furnace, and 50 lbs. on the second heat, while the third and later heats showed no further loss into the hearth.

Since most electric brass furnaces operating on alloys high in zinc work under slight pressure, the zinc vapor present in the furnace atmosphere may go through a too porous brick or a crack, and condense in the colder portions of the lining.

The presence of lead or zinc from these causes, or of fines of the alloy being melted that have run through a crack, not only tends to disintegrate the lining by expansion as the frozen metal heats up when the furnace is heated up again, but also cuts down the heat insulating value of the lining.

The lining is regularly composed of three layers, the inner of highly aluminous fire brick such as Corundite or Suprafrax, backed up by a layer of some lighter brick, less refractory, but a better heat insulator, which in turn is backed up by Silocel brick. Sometimes only two layers, Corundite and Silocel, are used.

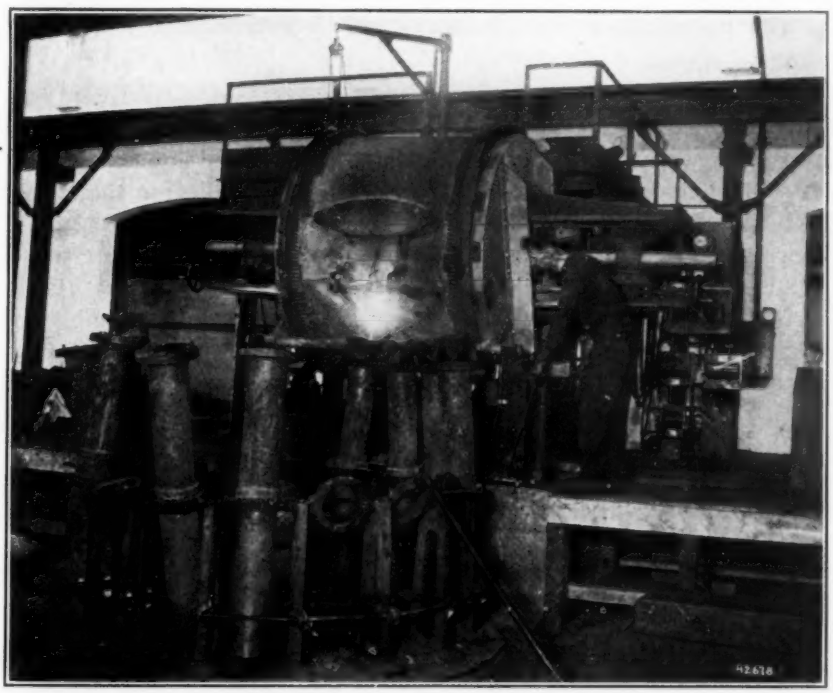


FIG. 4.—Detroit electric furnace pouring copper.

It is desirable to have good electrical insulation about the electrodes and that the hole through which they enter be smooth. Alundum cement is therefore used at these points.

The furnace rocks only slowly, making about two complete oscillations per minute, so that the eroding effect of the moving metal is not very great.

It is desirable from the operating standpoint to charge mechanically, rocking the furnace so that the charging door is up, and dumping the charge in through a funnel. The lining must stand this rather rough treatment.

The arc is supposed to be kept well centered in the furnace. Linings have been badly damaged by operation so careless as to bring the arc close to one end wall. The higher the refractoriness of the lining the less damage such carelessness can do.

The necessity for keeping the arc well centered so as not to overheat any part of the lining has made it desirable to use a single phase arc. From the electrical point of view the use of a three-phase arc would sometimes be advantageous and a couple of the moving indirect arc furnaces developed in this country, and those being developed in England and Germany, use three-phase arcs. None of these have yet come into real commercial use, and the shorter life of the refractories in such a design is one of its worst drawbacks.

The one-ton Detroit furnaces usually produce between 750,000 and 1,500-000 lbs. of metal before the inner course of brick is replaced. The bricks directly over the charging door are less thoroughly keyed in place than the rest of the lining, and countersunk holes are usually drilled in these brick and the brick held to the shell by bolts.

A very similar furnace, the Booth, has the charging door at one end of the furnace, the electrode support being attached to the door, and has the pouring spout also at the end. This furnace can be rotated completely, which involves the use of sliding contacts in the electric circuit. The furnace also has the further drawback of not being adapted to mechanical charging. As an offset to these drawbacks, it is somewhat easier to give stability to the lining of the Booth, as there is no opening on the circumference of the drum. Hence a one-piece refractory cylinder is used for the body and disks for the ends, making a three-piece lining. Suprafrax is commonly used for this. A layer of Silocel is placed between this lining and the furnace shell. The end of the furnace has to be taken off in order to reline the furnace. In a one-ton furnace it would be something of a job to insert a new inner one-piece lining satisfactorily without setting the furnace up on its end. The firing of a lining of that size also involves some problems for the refractory manufacturer. It is a question whether a one-piece lining, one made up of large blocks, or one made up of ordinary circle brick sufficiently true to shape to allow good brick-laying, will prove best in the long run.

The Booth rotating furnace is rarely used save in rather small sizes, 250 to 500 lbs. capacity. These give 150,000 and 300,000 lbs. as the average production between relinings.

Both Detroit and Booth furnaces are in use for melting cast iron, being especially useful where borings have to be melted. In such service a 250-lb. Booth produces around 60,000 lbs. between relinings, or less than half the average when operating on non-ferrous alloys.

The third important type of electric brass furnace is the vertical ring

induction furnace, shown in Figs. 5 and 6. In this furnace the heat is generated in the molten metal itself by virtue of its electrical resistance. Because the resistance is low, the current has to be very high and the cross section of the metal to be heated small. Hence the current is produced by induction and the resistor is a wide, but thin loop of molten metal so placed below the main body of the furnace that the tendency of a molten conductor to separate due to the so-called "pinch effect" is prevented by the hydraulic head of the metal above it. The furnace must have a complete loop of metal in the resistor to operate, so the furnace is not completely emptied, always operating with some molten metal in the bottom. A freeze-up ruins the lining, hence the furnace is run 24 hours a day, or, if not operated at night, is supplied with enough power to keep the metal left in molten.

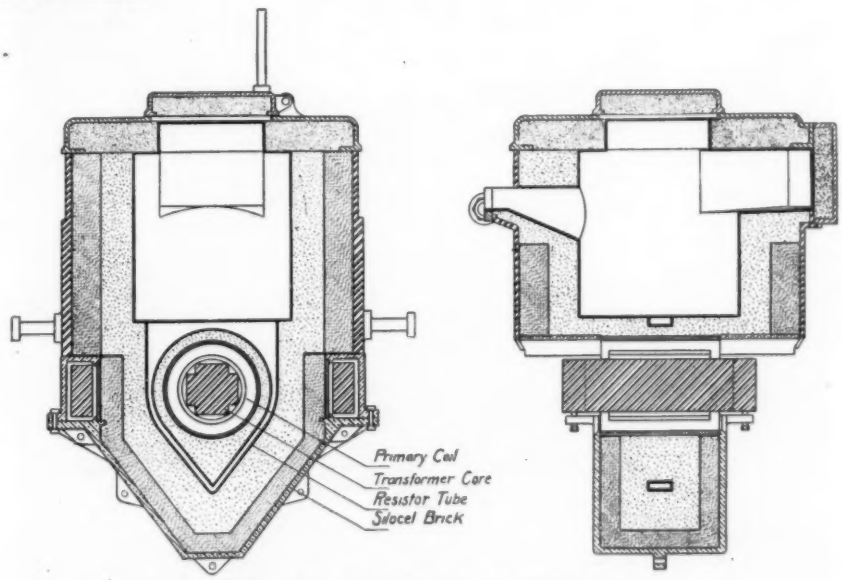


FIG. 5.—Diagram of Ajax-Wyatt electric brass furnace.

There is a constant flow of cooler metal into the resistor from above, and a constant forcing out of heated metal from the resistor into the hearth proper.

Since the heat is generated in the metal itself the refractories are not hotter than the metal. This type of furnace is extraordinarily compact and hence the wall losses are low. The furnace is inherently one of very great thermal efficiency.

The Ajax-Wyatt furnace is the only form of this type in real commercial use. This furnace is lined with a complete rammed-up lining of Johns Manville asbestos cement, No. 26 or No. 29, within a Silocel layer which

is next the shell. The lining is rammed up about a form, sometimes of wood which is removed, sometimes of brass which is left in and serves as the resistor when a newly lined furnace is being started up. In either case molten metal is poured in from another furnace when starting. Sometimes the lower half of the lining, about the resistor loop, is a molded refractory.

The lining inside the loop has to be thin on account of the small space allowed by the electrical requirements of this type. The primary coil and transformer leg within the loop are cooled by a current of air from a blower.

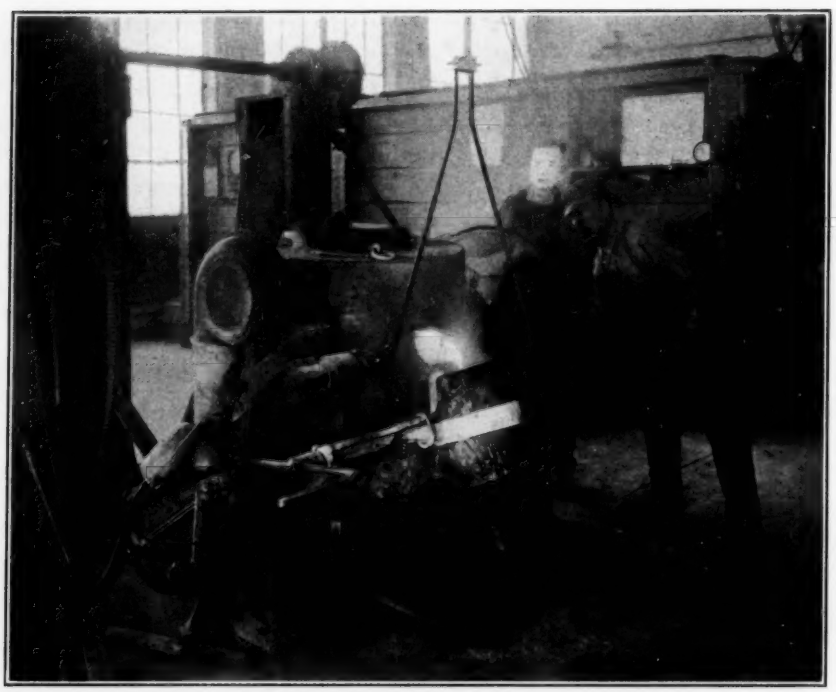


FIG. 6.—Ajax-Wyatt electric brass furnace.

In other types of electric furnace, penetration of the lining by metal is detrimental, but in this type it is fatal. If the metal works back to the shell so that the loop becomes short-circuited, further operation of the furnace is impossible. Hence it is essential that the lining be originally free from cracks or porosity, and remain so. Therefore the ramming must be most carefully done, and the lining must be very slowly and carefully dried out. Without the utmost care on this point, the lining may fail on the very first heat.

The choice of refractories is limited to those whose electrical conductivity is not too high, and whose heat conductivity is not too great, since the first would alter the electrical behavior and the second would endanger the primary and the transformer leg within the loop.

The slight flexibility afforded by the asbestos of the lining used gives, when the lining is properly installed, freedom from cracks. When used in 24-hour operation on the lower melting alloys, those high in zinc, which fortunately form a large proportion of the output of a brass rolling mill, this lining has a very satisfactory life, 1,000,000 lbs. being perhaps the average. One furnace was still going strong after melting 6,000,000 lbs. on one lining. These figures refer to alloys very low in lead. Even a lead content of 3 to 5% will reduce the life to something like a quarter of that on a lead-free alloy.

Since foundries generally handle alloys of 5% or higher lead, and seldom operate 24 hours a day, this type of furnace has not been found applicable to foundries save in rare cases. A lining that would stand up against lead and would not crack on heating and cooling would make this type of furnace more applicable to foundry conditions.

The refractory used in the Ajax furnace is quite satisfactory for rolling mill use on "high" brass, *i. e.*, brass high in zinc, but the lining which does so well there, does not do at all well when alloys on the high copper end of the scale, or when brasses containing nickel, *i. e.*, "nickel silver" or "German silver" are melted. It has recently been suggested by Stout[1] of the Phelps-Dodge Corporation that it might pay to finish the melting of cathode copper in the induction furnace. The rolling mills would like to be able to use the induction furnace on copper and alloys high in copper, but none of the linings so far tried have been fully satisfactory. One of the mills states that the development of such a lining would solve the most serious problem at present confronting users of the Ajax furnace.

Electrically sintered magnesite has been tried, and stands the temperatures and the action of the metals, but it cracks too readily. Chromite is now being tried out, but its performance is not fully satisfactory. Chromite has been tried in an electric brass furnace using electrodes and in which the furnace atmosphere is strongly reducing but the chromite was reduced too readily and the furnace wound up with a lining of ferrochrome instead of chromite.

The General Electric Co. has very recently brought out a slightly different form of the vertical ring induction furnace in which the lining is made in three large sections which when assembled and cemented together form the hearth proper and the resistor ring. This substitution of preformed and previously fired refractories is expected by the makers to allow the

[1] H. B. Stout, "One Phase of the Problem of Increasing the Consumption of Copper," *Mining and Metallurgy*, Nov., **1922**, p. 15.

application of the induction furnace to those alloys which the Ajax-Wyatt has trouble with, but the G. E. furnace has been too recently put out for results from users' tests to be available.

There are many other types of electric furnaces for non-ferrous alloys[1] each of which has its own special refractory problems, sometimes so serious that those problems alone have held up all development of the type. Some of the problems are as interesting as those of the furnaces of commercial importance, but space forbids even touching on the few other types of furnaces that find slight use on copper alloys.

There are several possible lines of advance in refractories that might be of value for copper alloy furnaces in general and electric furnaces in particular. For thermal efficiency it is desirable to have a graded lining, running from very refractory on the inside to the best possible heat insulator on the outside. Instead of using two or three layers, if the individual bricks were so graded from end to end, a more solid wall could be built. Quite a little experimental work has been done along these lines, but progress does not yet seem to have gotten to the point of commercial trial.

Another possibility is in the use of real refractories even though they be expensive. From his own laboratory experience with alundum, the writer would expect that a furnace with an inner lining of alundum brick would stand up for a very long time in a rocking furnace. Unfortunately, when the writer was experimenting with a commercial sized rocking furnace in the early days of its development, it was not possible to buy enough such bricks at any price. Carborundum brick have proved to be worth their high price for many uses, but their heat conductivity is so high that a carborundum lining thick enough to be mechanically stable would generally involve either too high heat losses or too high heat storage in an electric brass furnace.

Zirconia refractories ought to be just the thing on account of their reputed refractoriness, resistance to penetration by metal, resistance to spalling and low thermal conductivity. The actual zirconia refractories that have been tried out, as far as reports have reached the writer, did not live up to their reputation. Nevertheless it is almost certain that when sufficient work has been done on zirconia, a real refractory will result.

Since metal tightness and resistance to spalling or cracking under change of temperature are so important, ordinary magnesite or silica has little promise. Since the highly aluminous fire brick are standard for a good many electric brass furnaces, it is quite likely that the new electrically prepared, pre-shrunk refractories of that type may be even better.

The user of an electric furnace is naturally rather coy about trying out a new refractory at around $1.00 a brick without some assurance that

[1] See H. W. Gillett and E. L. Mack, "Electric Brass Furnace Practice," *Bull.* **202**, U. S. Bur. Mines, 1922.

the increased life is going to be worth the price. But even such a price would not be impossible if the lining would really stand up. The first cost of a new lining is not so important as the loss of use of the furnace while it is down for relining. The maker of expensive refractories would find it a good investment to give away brick for trial linings if he really has something that will stand up, in order to establish records of long life in actual commercial use. Without such coöperation by the manufacturer the use of super refractories will be a matter of slow growth in these furnaces.

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SILICATE OF SODA IN THE CERAMIC INDUSTRIES

By James G. Vail

ABSTRACT

The term "silicate of soda" is applied to a number of products of varying properties. Cements made with one variety ($Na_2O.2.4SiO_2$) as a binder have been widely used for mending saggers. The deflocculation of clay with silicate in connection with refining and casting has been studied but the advantages offered by the varieties of silicate have not been considered. This appears to be a fertile field for investigation. Another important use for silicate of soda ($Na_2O.2SiO_2$) is in the manufacture of abrasive wheels. Although this process is old, there is still much to be learned about it.

A consideration of silicate of soda in the ceramic industries or, for that matter, in any industry must be predicated on an understanding of what is meant by the term silicate of soda. In a commercial sense silicate of soda is not a more definite term than clay. Its connotation is generic rather than specific. Attention must be called to this fact because in spite of a voluminous literature there are still many technical men who think of a definite sodium silicate when they see the syrupy liquid of commerce.

Sodium meta-silicate has been studied by several workers, notably Erdenbrecher, who has prepared three crystalline hydrates of Na_2SiO_3 with four, six and nine molecules of water, respectively. These may all be prepared at ordinary atmospheric temperatures. They all melt in their water of crystallization to liquids of low viscosity relative to the commercial preparations on the American market.

The ratio of Na_2O to SiO_2 is the usual index of the type of a commercial silicate solution. As the percentage and molecular ratios are so nearly alike custom has chosen the more convenient percentage ratio. This may vary between the 1:1 of the meta-silicate up to 1:4 or even higher. The properties of the products at the two ends of the scale are very different and any intermediate composition can be produced in general without sharp breaks in the curves which represent the changing characteristics. Although it is likely that a compound of the ratio 1:2 does exist its presence in the familiar solutions of this composition has not been completely proven. It is important then when you hear or read about silicate of soda to think—which silicate of soda?

Perhaps the use of silicate of soda for mending saggers is more widely applicable in the ceramic industries than any other. Where the break is a simple one, the process of repair is so simple as to be a marked economy. For this purpose a silicate which dries in the air to form a firm joint and retains its bonding quality as the temperature rises should be selected. All air dried silicate solutions, even when they develop a bond strength above a thousand pounds per square inch, are hydrous. They can be completely de-hydrated only at kiln temperature. During the removal of the last few per cent of water the bond strength of most silicate solutions is much

reduced. At temperatures near 2000°F sintering begins and the silicate again is sticky and has holding power. The ratio which we have found most suitable for this sort of work is about $Na_2O:SiO_2::1:2.4$. If a grade containing more silica is used, its strength will decline earlier with advancing temperature. If a more alkaline type be selected the cement will have a lower melting point and will set too slowly at atmospheric temperature. Silicate of soda should be mixed with a refractory clay to make the sagger mending cement. A mixture of calcined and raw clays is best though not essential. A wide variety of clays can be used. The silicate of ratio 1:2.4 is usually sold as a solution of about 47% solids testing 52° Bé. About two parts by weight of this and one part of powdered clay should be used. A little water may be added to permit mixing the cement to a smooth thick creamy consistency. It is best to paint both broken surfaces of the sagger with the cement taking care to apply enough to prevent a premature set due to absorption of water from the wet cement by the porous body of the sagger. This would occur only when the cement is spread very thin. Enough should be used to allow the cement to remain sticky for five minutes if exposed to the air. The broken parts should be pressed together so that a little is squeezed out and allowed to stand undisturbed over night. A joint formed in this way is usually stronger than the body of the sagger.

Cements made with clay and silicate of soda are also useful in making gas tight brick work in kilns, boiler furnaces, coke ovens and the like.

The influence of electrolytes on the suspension of clay in water as applied to refining and casting has received a great deal of attention and is the subject of a fairly voluminous literature. Beginning with a discussion of Acheson's paper on Egyptianized clay before this SOCIETY in 1904 when W. D. Gates called attention to a similar effect of silicate of soda on clay, members of the AMERICAN CERAMIC SOCIETY have made numerous contributions to our knowledge. Bleininger and Schurecht should be especially mentioned in this connection. It is worthy of note that much that has been written is either unclear or entirely silent as to the kind of silicate employed. All solutions of silicate of soda will indeed assist in the suspension of clays and up to an optimum concentration make the separation of other minerals easier. In each case amounts beyond the optimum concentration produce a lesser effect or cause the flocculation of the suspended clay. The work of Schurecht has shown that the effect of silicate is not merely the effect of a given amount of sodium oxide which may be added in any convenient form. A unit of Na_2O as sodium silicate has a larger effect in reducing the viscosity of a clay slip than the same amount of Na_2O added either as hydroxide or carbonate. The silica must enter into the reaction and it appears that a study of the various types of silicate with different ratios of $Na_2O:SiO_2$ would be a valuable contribution to our knowledge of

the art. The hydrogen ion concentration is certainly an important factor in the effect of electrolytes on clay suspensions; the different types of silicate provide a convenient means for securing the concentration suited to the manipulation of each particular clay and the buffer effect of the silica should make it more easy to control the characteristics of the slip or the suspension in the refining process.

The varieties of silicate of soda should also be studied with reference to their effect on the density shrinkage and strength of the ware. If one form of sodium silicate added to a clay in amounts of less than 2% based on a 40% solution can cause differences of more than 100% in the dry strength or the fired strength of clays it is a matter of concern to know whether the form arbitrarily chosen for the study was in fact the most suitable. We have abundant evidence that the various forms do not behave alike.

One of the oldest uses of silicate of soda is to form a bond for abrasive materials in the manufacture of grinding wheels and abrasive stones. The process is widely used and has numerous advantages important among which is the possibility of forming a wheel on one day and putting it into service the next. The silicate bond easily produces masses having a tensile strength of 2000 pounds per square inch and the loss in process is very small. The silicate ordinarily employed for wheel manufacture has a ratio of 1:2 and is concentrated to a very sticky solution containing about 54% solids. This solution is mixed with approximately an equal weight of a finely pulverized mineral such as clay or silica. The chemical characteristics of this powder can be varied considerably and good results secured but its fineness and the thoroughness with which it is mixed with the silicate solution and the abrasive grains are important. The tamping of the mixture into molds calls for experience and skill to produce a uniform body. The wheels are first air dried at temperatures below the boiling point of water for a length of time dependent on the size of the wheel and then baked at about 450° Fahrenheit for several hours. The chemistry underlying this process is not fully understood although a large amount of practical experience has developed a technique which gives good results. It is not, for instance, known that there is any reaction between the mineral filler and the silicate solution and yet wheels are made sufficiently resistant to water to be run wet.

The water resistance of some mixtures is, however, improved by the addition to the inert mineral of small quantities of oxides capable of reacting with the silicate at the temperatures used in the process. One of these is zinc oxide. Fundamental research on the reactions of the silicate abrasive wheel process is needed to understand what has been empirically found to be good practice and to point the way to improvements. We already know that a silicate of very different character from those used for adhesive purposes is required.

Whether it be the making of silicate cements for mending saggers and setting brick with gas tight joints, or the regulation of the flowing and suspension characteristics of mixtures of clay and water with small additions of silicate solutions, or the manufacture of quick process silicate abrasive wheels, the fact is worth remembering that the various forms of silicate have different properties. The grade best suited for one process may be quite unfit for another and many a process can be perfected by choosing a silicate solution adapted to the peculiarities of the clay with which it comes in contact and the conditions of its use.

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CERAMIC ABSTRACTS

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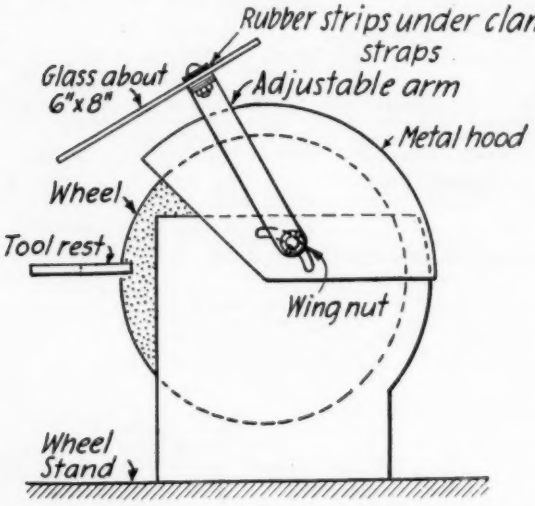
Abrasives

1. Glass shield for emery wheel. ANON. *Queensland Gov. Min. Jour.*, **23**, 422 (1922).—The glass shield shown in the accompanying illustration has been found of considerable value in protecting operators of emery wheels. It obviates the use of goggles, with all their attendant troubles, such as broken parts, dirty lenses, and the general dislike manifested toward them. In addition, the operator cannot inhale the particles thrown up by the wheel. This is a greater menace than is ordinarily supposed, as large numbers of these particles are not visible but show their presence by pitting the shield. The glass used is a piece of plate from a broken windshield, and all the material is usually available in the ordinary shop. By mounting the glass in a hinged holder, it can easily be pushed out of the way when desired. Various adaptations can be made so that the shield will work without interfering with the usual operations in a shop. O. P. R. O.



2. Abrasives—an outline of their history. M. HANEY. *Raw Material*, **5**, 350–2 (1922). E. J. C. (*C. A.*)

Art

3. Color designation. HEINRICH TRILLICH. *Farben-Ztg.*, **27**, 3323–4, 3379–80 (1922).—Cf. *Ceram. Abs.*, **1**, 256(1922); *ibid.*, **1**, 322(1922). F. A. W. (*C. A.*)

Cement, Lime and Plaster

4. Automatic vertical furnace for the baking of cement. E. CANDLOT. *Chimie et Industrie*, **8**, 1206(1922).—The rotary furnace, now generally used, has several disadvantages namely, increased consumption of coal, use of considerable motive force, and loss of time caused by the frequency of delays for repairs. The uninterrupted working period of a rotary kiln is generally only 3 mos. and sometimes less. The vertical furnace is free from these faults to a greater extent and therefore research workers in France have been working on perfecting an automatic vertical furnace with device for loading and unloading. A history of the progress made from 1913 is given; the different makes of furnaces used and the choice of the most advantageous diam.. The quality of cement obtained is of the highest. The cost of installation is much lower than that of the rotary furnace. Considerably less fuel and power is used in operation. With these advantages the new system of furnace ought to be widely adopted. It is, as yet, practically unknown on this continent, but is being very successfully operated in several large French plants. O. P. R. O.

5. Caustic magnesia cement. ANON. Bur. Standards, *Circ.* **135**(1922).—The cement resulting from the reaction of caustic magnesia with a soln. of magnesium

chloride has been known for more than half a century, and some of the products made therefrom, in the form of resilient flooring, stucco, and ship decking, have been on market for considerably more than half that period. References are given to the discovery and early history of this cement. A summary of the investigative work dealing with the process and products of setting is presented. Certain tentative test requirements and methods for conducting tests of the oxide are given. H. F. STALEY

6. Influence of the hardening of cement and lime mortars in steam under pressure on the mechanical strength of these mortars. LÉON BERTRAND. *Bull. officiel direction recherches sci. ind. inventions*, No. **36**, 608–15(Oct., 1922).—Steaming under 8 kg. (per cm.^{2}) for 3.5 hrs. doubles the strengths of neat cement and of mortars (1 of cement to 2 of sand), and gives them the same hardness as test pieces kept at ordinary temp. for a month. Too rapid cooling affects the strength adversely. The conditions of further tests on cement and hydraulic lime are described in detail and the results are tabulated and shown graphically. The strength of the pieces treated in the usual manner increased during the whole 12 weeks of the tests. In pieces treated in the autoclave, the tensile and crushing strengths both decreased fairly rapidly, reached a min. in less than 7 days, and then increased fairly rapidly, the lime regaining its initial strength and the cement exceeding it. The similarity in the behavior of the lime and of the cement tends to show that the phenomena of setting are of the same nature in both and probably related to the development of aluminates. The action of steam in the autoclave treatment causes a progressive transformation which gives rise to some unstable form of combination, which gradually changes to a stable state. As the strength of the steamed test pieces is in every case much higher than that of the unsteamed pieces, the final stable state of the former must be quite different from the final state obtained by ordinary setting in a moist atm. or under water at the ordinary temp.

A. P.-C. (*C. A.*)

7. A study of chemical reactions in the burning of lime and portland cement. G. A. RANKIN. *Concrete* (Mill section), **21**, 72–77(1922).—The paper is principally concerned with the cement kiln but some of the data are also applicable to lime burning. Three series of reactions are considered: (1) the driving off of CO_2, (2) formation of the clinker, and (3) the burning of fuel. The work involves the investigation of samples taken every 10 ft. throughout the length of a 125-ft. kiln (the ordinary chem. analysis is supplemented by microscopic examns.), and lab. expts. On the basis of this work, the work of other investigators, and theoretical considerations, R. concludes that the first two series of reactions take place economically but the third is not economical. The temp. of the flame should be increased; one way to do this is to supply O for burning the fuel rather than air. J. C. W. (*C. A.*)

Glass

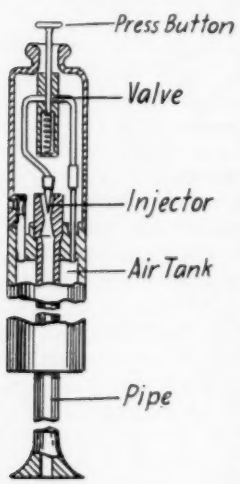
8. Silica glass, its properties, history and manufacture. GEORGES FLUSIN. *Le Verre*, **2**, 145–53, 171–7, 193–8, 217–21, 241–4, 266–73(1922).—A complete detailed review of the phys. and chem. properties of the allotropic forms of silica, with special reference to silica glass, to which is appended a bibliography of 130 references subdivided according to the headings, allotropic transformations of silica, volatilization, density, expansion, sp. heats and transformation, thermal cond., optical properties, elec. resistance, devitrification of silica glass, melting points of silica, mechanical properties, permeability to gases, chem. properties of silica glass. The history covers the various mfg. companies in England, Germany, France, Switzerland and the U. S. A. The manuf. of silica glass considers the different types of furnaces (with cuts) used, and the making of semi-opaque and transparent varieties, also the silica glasses containing ZrO_2 and TiO_2. The devitrification of silica glasses, and their uses complete the series.

Some 80 patents on silica glass are listed, together with 60 references on the silica glass industries, which seems to be complete to 1920. LOUIS NAVIAS

9. Glass manufacture—India. C. S. FOX. *Bull. of Indian Indus. & Labour*, **29**(1922).—This bull. gives the early history of glass; reviews the glass industry in India and defines the properties common to the many varieties of glass. A flow sheet is given, showing a general idea of the glass manuf., beginning with the raw materials most commonly used; the treatment they receive prior to being added to the furnace as "batch;" the processes to which the plastic glass is subjected in making the various types of glass ware; and the tempering and finishing operations involved before the product is ready for market. Prepn. of the batch is discussed; glass furnaces are described, with accompanying cuts; glass and glassware, manuf. of different kinds of glass, annealing and finishing operations are discussed. The field is attractive from a business point of view, and with the establishment of several carefully located glass works not only would the Indian demand be met, but the whole eastern market would in time be supplied. O. P. R. O.

10. Unbreakable glass in Czecho-Slovakia. M. V. HORÄK. *Pottery Gazette & Glass Trade Rev.*, **48**, 300(1923).—*Reutzer Trade Service* reports establishment of a firm for the exploitation of a new process for the manufacture of unbreakable and non-fusible glass discovered by a Czech engineer, M. V. Horäk. O. P. R. O.

11. Mechanical glass-blowing.—Use of compressed air. ANON. *Industrial Austral. & Min. Standard*, **48**, 891(1922).—A Hamburg engineering correspondent of the *Times Trade Supp.* gives some particulars of a mechanical glass-blowing device. In the manuf. of sheet glass, he says, the blowing pipe still remains a most important tool. It consists of an iron tube about 4½ ft. long. On one end of it is gathered a mass of molten glass, and this the blower forms into a large elongated cylinder by blowing down the tube, the operation being assisted by gravity and by rotating the tube. To replace this process of blowing by the mouth, which is necessarily irregular, a method which makes use of compressed air has been devised by W. Lippold, of Dresden. The compressed air, however, is not used directly, but is employed to draw, by a jet action, a small stream of air into the pipe. A compressed air reservoir is combined with the pipe, which is, therefore, independent of any air hose, and can be turned in any direction as easily as a mouth-pipe. Regulation of the air stream can be effected very exactly by a small valve worked by a press-button, which is pressed by the chin of the blower or by a finger. If a blower makes 60 cylinders, each 4 ft. long and 1½ ft. in diameter, in 8 hrs., he has to blow in some 400 cu. ft. of air. The mechanical blowing pipe saves him this exertion, and also, it is said, considerably increases the output. O. P. R. O.



12. Some observations made on the electrolytic migration of sodium through glass. M. PIRANI AND E. LAX. *Z. tech. Physik*, **3**, 232–5(1922).—The film of water which persists inside of an evacuated glass tube was removed by the migration of Na ions through the glass. A tube shaped like a lamp bulb and contg. a small W wire was evacuated and immersed in molten $NaNO_3$ at 450°. The wire was heated to a high temp. and a potential of 200 v. was applied between the wire and the molten bath. Na ions migrated through the glass and a yellow luminescence was produced in the tube. The H_2O film was displaced by this process and was attacked by the hot W as evidenced by the formation of a film of blue WO_3 on the tube. After 10–15 min. the H_2O film was

entirely removed. The method was used for making a Na glow-tube for demonstration purposes. H. B. W. (*C. A.*)

13. Problems of the German glass industry. H. KÜHL. *Chem.-Ztg.*, **46**, 990–2 (1922). E. J. C. (*C. A.*)

14. Pyrex glass. PAUL ÉMILE ERCKMANN. *Chimie et industrie*, **8**, 785–91(1922).—A discussion of the requirements of an ideal glass, with a description of the compn. and merits of Pyrex glass and its uses. A. P.-C. (*C. A.*)

15. Operating life of tanks. H. W. HESS. *Glass Worker*, **42**, No. 5, 13(1922). J. B. P. (*C. A.*)

16. Raw material selection. H. W. HESS. *Glass Worker*, **42**, No. 7, 13; No. 8, **13**, 40(1922).—Natural products such as sand, feldspar, etc., need careful checking while trouble caused by impurities in manufd. articles such as soda ash, litharge, etc., is comparatively rare. J. B. P. (*C. A.*)

17. Glass industry fuel waste. A. J. RITTMAN. *Glass Worker*, **42**, No. 9, 13, 38, 40(1922).—There is still much unnecessary waste of fuel due to improper manipulation of valves and dampers in the furnaces and the use of too much steam in the producers. J. B. P. (*C. A.*)

18. The chemist in the glass factory. H. W. HESS. *Glass Worker*, **42**, No. 10, 21–2(1922). J. B. P. (*C. A.*)

19. Fire polishing glassware. H. W. HESS. *Glass Worker*, **42**, No. 11, 11, 29 (1922).—Sulfuring is remedied by changing the flame from a reducing to an oxidizing condition where it impinges upon the ware. Irregularities in pressure and quality of the gas must be avoided. Compressed air should be scrubbed as it contains dust and oil. The flame temp. of natural gas is insufficient for some purposes, it being often necessary to change to artificial coal gas of lower calorific value but higher flame temp. J. B. P. (*C. A.*)

20. Detecting stoppages in furnaces by vacuum readings. HENRY W. HESS. *Glass Worker*, **42**, No. 4, 13(1922).—Under normal conditions a glass furnace should show a positive pressure of the contained gases at the edge of the crown. Half way down, the gases should show a slight pressure and at the floor level, the condition should be approx. balanced between pressure and vacuum. At the outlet of the waste gas checkers there should exist a slight vacuum, while a waste gas flue which does not leak too much should show a steady rise in vacuum to the base of the stack where it should measure from $^3/_8$″ to $^5/_8$″. J. B. P. (*C. A.*)

PATENTS

21. Glass-grinding machine. HARRY M. BARBEAU. U. S. 1,430,879, Oct. 3, 1922. The combination of a rotary grinding member, a member for supporting a plurality of sheets of glass edgewise, the supporting member being located to the grinding member, means for raising and lowering one of the members to adjust distance between the 2 members, and means for rotating both of the members. C. M. S., JR.

22. Apparatus for and method of drawing sheet glass. JOSEPH P. CROWLEY. U. S. 1,428,533, Sept. 12, 1922. In an app. for continuously drawing sheet glass, a rotary device for flattening the sheet carrying surface of the device comprising a series of plane surfaces symmetrically arranged about the axis of the device, and sharp wear-resisting members at the edges formed by the intersecting plane surfaces, the edges engaging and holding the sheet, and the sheet being flattened upon the intermediate plane surface. (Cf. *Ceram. Abs.*, **1** [12] 332(1922).) C. M. S., JR.

23. Glass. FRED M. LOCKE. U. S. 1,431,166, Oct. 10, 1922. A glass containing silica, boric oxide and an alkali earth, and having a coeff. of expansion not greater than .0000035. C. M. S., JR.

24. Apparatus for manufacturing glass articles. WILLIAM J. MILLER. U. S. 1,428,855, Sept. 12, 1922. In a paste mold machine, a revolving support, a fixed gear axially aligned with the support, pairs of pipe rotating rollers moving with the support, gears carried by the rollers and meshing with the fixed gear to rotate the rollers, and means for resiliently pressing the rollers into engagement with the blow pipes.
C. M. S., JR.

25. Apparatus for the production of spun glass. GEDEON VON PAZSICZKY. Germany. 1,427,014, Aug. 22, 1922. An improved app. for the production of spun glass having outflow orifices in its bottom plate, a vertical tube in the receptacle having inflow ports adapted to register with the inflow ports of the vertical tube so that a determined quantity of molten glass can flow from the receptacle into the inner revolvable tube, means for exerting a pressure upon the molten glass in the inner tube, and a revolving cylinder under the receptacle upon whose surface the drops of glass adhere which come off the orifices and around which the glass threads are wound which are drawn by the drops. C. M. S., JR.

26. Glass-grinding machine. EDWARD A. RYON. U. S. 1,429,106. Sept. 12, 1922. In a glass banding machine, a cutting member, a swinging support movable toward and away from the cutting member and a rotatable workholder pivotally mounted on the swinging support and thereby adjustable to vary the angle of the face of the work with respect to the face of the cutting member and yieldable means at the side of the cutting wheel for engaging and supporting the work as it is pressed against the cutting wheel. C. M. S., JR.

27. Apparatus for and method of producing charges of molten glass. LEONARD D. SOUBIER. U. S. 1,428,994, Sept. 12, 1922. In gob forming app., the combination of a container for molten glass having an outlet opening through which the glass issues, means to periodically sever the glass at a point adjacent the opening, means to subject the issuing glass to a reduced pressure without mechanical contact with the glass during the initial portion of each period after the glass is severed, and a regulator operating periodically within the container to exert an expelling force on the glass after it has been subjected to the reduced external pressure. C. M. S., JR.

28. Glass manufacturing machinery. SAMUEL E. WINDER. U. S. 1,431,436, Oct. 10, 1922. In a glass mfg. machine, glass blowing mechanism, means for transferring the blanks from the molding mechanism to the blowing mechanism, the means comprising a clamp for grasping one end of the blanks, means for enclosing the other end of the blanks, and means for elevating and lowering the clamp independently of the enclosing means. C. M. S., JR.

Heavy Clay Products

29. Recommended minimum requirements for small dwelling construction. BUILDING CODE COMMITTEE. Bur. Standards, *Report* (1922).—Investigation by a Congressional Committee during 1919 and 1920 disclosed that existing building laws, through variations and inconsistencies of their provisions and through unduly restrictive or expensive requirements, were operating to prevent needed activity in the building industry. The Committee recommends that building codes permit 8-in. solid brick and 6-in. solid concrete walls for $2^1/_2$-and 3-story dwellings accommodating not more than two families each; that 8-in. hollow building tile, hollow concrete block, or hollow walls of brick (all rolok) shall not exceed 20 ft. in height to the gables; and that frame construction be limited to $2^1/_2$ stories. Metal lath and plaster on wood studs properly fire-stopped is approved for party and division walls, but at least every alternate wall in row houses must be 8-inch solid brick or concrete or 12-inch hollow building tile, concrete block, or hollow wall of brick. Live loads to be required as bases for design

are 40 pounds per sq. ft. for floors of wood, and 30 for those of monolithic type, or of solid or ribbed slabs. Foundation walls of brick are required to be 12 inches thick for excavated enclosures, and similar concrete walls shall be as thick as the walls they support but not less than 8 inches. Special hollow building tile 12 inches thick is permitted for foundation walls of frame buildings. H. F. STALEY

30. Test of a hollow tile and concrete floor slab reinforced in two directions. W. A. SLATER, ARTHUR HAGENER AND G. P. ANTHES. Bur. Standards, *Tech. Paper* **220**, (1922).—A large slab, 48 by 115.5 ft. center to center of outer supporting girders, was loaded. In the 48 ft. dimension the slab was divided into three spans of 16 ft. each. In the 115.5 ft. dimension it was divided into six spans, two end spans were 16 ft. each, the two middle spans 19.25 ft. each, and the two spans at the other end were 22.5 ft. each. Girders extended along all panel edges, and columns stood at all intersections of girders. The slab was 6 in. thick over all and was made up of 6 by 12 by 12 in. clay tiles laid in rows parallel to the panel edges with ribs of concrete 4 in. wide and 6 in. deep between rows of tiles in both directions. Each concrete rib was reinforced with one $^1/_2$-in. round bar in the top for negative moment and with the same moment extended out into the panel one-fourth of the span length in the direction of the bar and were there hooked for anchorage. The slab reinforcement had a yield point of about 54,000 and the girder reinforcement of about 46,000 lb. per sq. in. According to current methods of design, the working loads (sum of live and dead loads) for the three sizes of panel would be 83, 67, and 48 lb. per sq. ft. for the square, intermediate-size, and long interior panels, respectively. The weight of the slab was approximately 50 lbs. per sq. ft. For about two months the square panels stood under a uniform load (sum of live and dead loads) of about 450 lbs. per sq. ft., the intermediate-size panels under 330 lb. per sq. ft., and the long panels under 280 lb. per sq. ft. The load was then shifted and (with smaller loads on adjoining panels) the loads for the succeeding 6 months on certain panels were: square panels 780, intermediate-size panels 655, and long panels 555 lb. per sq. ft. Finally the load was concentrated still more and for about 11 months the loads on single panels of each size have been: square panels 1463, intermediate-size panels 1234, and long panels 970 lb. per sq. ft. Both the deformations and the deflections increased when the load remained constant over a considerable time, but the fact that so great a load has been carried for so long a time without excessive deflection removes any misgiving as to the adequacy of the form of construction used. H. F. STALEY

PATENTS

31. Hollow tile building block. AUSTIN F. JONES. U. S. 1,432,068, Oct. 17, 1922. In a building element of the character described a hollow block grooved upon its outer face to represent a plurality of superimposed bricks with a plurality of interlocking projecting portions extending from the end of each block adjacent to its outer face the projecting portions having a relatively wide base adjacent the block and tampering in a blunt outer end the projecting portions alternating with recesses in the body of the block shaped to receive like interlocking projecting portions of a similar block when placed in adjacent relation. C. M. S., JR.

32. Interlocking brick. CHARLES H. LEICESTER. British Columbia. 1,431,530, Oct. 10, 1922. In a wall construction of the character described with the bond laid longitudinally, a plurality of layers juxtaposed blocks, key portions on the blocks forming spaces, the key portions of the blocks in one row of blocks fitting into the spaces formed by the key portions on the opposite side of the blocks in the adjoining row, and keyless blocks to form the upper and lower rows for forming openings between the upper and lower rows and the rows next adjoining the upper and lower rows.

C. M. S., JR.

33. Interlocking brick. JESSE C. MARTIN, JR. U. S. 1,431,318, Oct. 10, 1922. A brick having bosses upon a surface thereof and receptacles indented upon the opposite surface thereof, the bosses and receptacles being coaxial and being spaced equally from an end, the sides and the center line of the brick, the depth of the receptacles being greater than the height of the bosses. C. M. S., JR.

34. Tiling block. JOHN T. PRATT. U. S. 1,432,567, Oct. 17, 1922. A tile having a backing substantially rectangular in shape, the backing having one side and one end wall beveled, the backing having the outer side and end wall beveled opposite to the side and end wall first mentioned, and attaching flanges secured to and projecting beyond the backing at one side and one end thereof. C. M. S., JR.

Refractories

35. Refractories. P. S. DEVEREUX. *Jour. of Birmingham Met. Soc.*, **8**, 53–64.—A review of the whole subject of refrac. materials as follows: resistance to destructive agents; crushing strength; effects of load on various fire bricks; chromite, magnesite and dolomite refrac.; higher refrac. such as carborundum, fused alumina, zirconia, etc.; standardized testing and conservation of fuel. A paper given before members of the Society with discussion. O. P. R. O.

PATENT

36. Refractory heat-insulation. F. OTTMAN. U. S. 1,435,416, Nov. 14. A compn. suitable for building fire-resisting walls is made from kieselguhr 81 mixed with fibrous asbestos 9 and Ca phosphate (formed from lime and H_3PO_4) 10 parts. (*C. A.*)

Whitewares

37. The burning of porcelain. G. H. BROWN. *New Jersey Ceramist*, **1** [3], 204 (1921).—A discussion of the principles controlling the burning of porcelain. Failure to burn out all of the carbon from ball clay may give rise to a slight swelling of the ware and a spongy structure. It is recommended that in the firing, fuel should be introduced in relatively small charges at frequent intervals, rather than heavy charges at long intervals. The method employed in burning porcelain in Europe is discussed at length, following the information given by Dr. A. Heinecke, Director of the Royal Porcelain Factory, Berlin. The European practise is summarized as follows: (1) The ware is biscuited at a low temp. (about cone 09) reducing conditions being maintained throughout. If the chemically combined water is not completely driven out, it will retard diffusion of the reducing gases and reduction will be incomplete toward the center of the piece. Deposition of carbon may occur due to the reaction between the water vapor and hydro-carbon gases. This carbon may be removed only by prolonged heating under oxidizing conditions. From 3 to 5% carbon monoxide should be present in the kiln gases. Black smoke should be avoided. (2) Glost burning is divided into three periods, the "heating up," the reducing and the finishing periods. Deposition of tarry distillate products in the porous ware may subsequently cause blow holes, or pockets, unless this carbonaceous material is carefully removed by oxidation. (3) Oxidizing conditions are maintained during the heating up period, which extends from the beginning of the burn to the softening of cone 09. (4) Reduction extends from cone 09 to cone 8 or 9, the latter point depending somewhat upon the constitution of the body and of the glaze. The fuel gases may contain 5% hydrogen and carbon monoxide. Heating should not proceed too rapidly. Iron which has been converted into ferric oxide during the preparation of the body may be reduced to metallic iron in the body or glaze. Bodies containing iron in this form should be lightly oxidized toward

the finish. Some of the salts or alkaline earths which are present in the materials, or have been introduced in the molds may be decomposed by the reducing gases. If these gases are not allowed to escape, cavities or blebs are likely to form in the body or glaze. After the glaze has fused, the kiln atmosphere may be maintained in a neutral condition. (5) The finishing period extends from the softening point of cone 8 or 9 to the completion of the burn. Strong reduction is avoided and the atmosphere is maintained as nearly neutral as possible. An excess of 1% carbon monoxide, the exact quantity varying with the nature of the product, is not objectionable. In the burning of porcelain decorated with overglaze or underglaze containing reducible metal oxides, reduction should be followed by re-oxidation of the color oxides. It is important to know the quantity of excess oxygen present in the kiln at the beginning of the sintering of the glaze as a guide in the oxidation. An excess of 1% oxygen is ample for this purpose. C. W. PARMELEE

PATENTS

38. Joint for articles of ceramic and similar materials and method of producing same. ARTHUR O. AUSTIN. U. S. 1,431,137, Oct. 3, 1922. In combination a plurality of ceram. bodies having surfaces adjacent one another and spaced apart by interposed particles fused to the surfaces to connect the bodies to one another. C. M. S., JR.

39. Spark-plug insulation. T. G. MCDOUGAL. U. S. 1,434,133, Oct. 31. Bentonite 5% or less is used with calcines 60%, china clays 30% and a small amt. of ball clay. (*C. A.*)

Equipment and Apparatus

40. Separation of graphite by froth flotation method. W. GROSS. *Z. angew. Chem.*, **35**, 681.—The crude graphite of Sacrau, Silesia, contains on an av. 31.5% of carbon. The sepn. of this from the associated mineral by the froth flotation method has been investigated on a lab. scale, using machines in which the air to form the froth is drawn in by the rapid agitation of the mixt., and also of the type in which air is forced through a porous bottom. Wood-tar distillates were used as froth promoters. Best results were obtained with "beechwood tar oil No. 3," a heavy distillate, of which 1.49 kg. per T. of crude graphite was used, the mixt. being acidified with 1.23 kg. of sulphuric acid on the same quant. O. P. R. O.

41. Remarkable grinding mill. H. PLAUSON. *Brit. Clayworker*, **31**, 332(1923).—A mill, which can grind materials so fine that they enter into the colloidal state and so remain in suspension for an indefinitely long period, has been invented by Dr. Plauson and is now obtainable in commercial sizes. This "colloid mill" resembles the ordinary disintegrator used for very wet materials, but is driven at a much higher speed (3,000–4,000 r. p. m.). The material to be ground is mixed with 8 or 9 times its wt. of water, and is then passed through the mill, which reduces the solid particles to less than $^1/_{20,000}$ in. in diameter, and as their surface tension is greater than the effect of gravity, they remain in suspension until pptd. by chem. or other agent. This machine is capable of many uses and by its means clays of exceptional fineness can readily be prepd. The ground materials can only be sepd. from the water or other fluid in which they are suspended by passing the mixt. through a special filter. (*Tonindustrie Zeitung.*) O. P. R. O.

42. Development of the filter press. C. L. BRYDEN. *Chem. Age* (N. Y.), **30**, 493–5(1922). E. J. C. (*C. A.*)

43. Standardization of laboratory gas cocks. S. W. PARR. *J. Ind. Eng. Chem.*, **14**, 1105(1922); 3 cuts.—Various objectionable gas cocks now in general use are illustrated and discussed. A working sketch is given of a satisfactory cock to be used by the Univ. of Ill., which specifies optimum length of hose connection and size of corrugations.

The outer edges of the corrugations have slight angles instead of round surfaces, permitting easy slipping on of connection tubing but resistance to its removal.

T. F. B. (*C. A.*)

44. A new instrument for sampling aerial dust. LEONARD GREENBURG AND GEO. W. SMITH. Bur. of Mines, *Repts. of Investigations*, No. **2392**, 3 pp.(1922).—In this new impinger-bubbler type of app. the dust-laden air is caused by a blower to impinge at high velocity on a wetted glass surface, and subsequently to bubble through a liquid medium. The efficiency of the app. tested against tobacco smoke and silica dust, both gravimetrically and by means of the Tyndall effect, is from 9 to 31% higher than that of the sugar tube app. It possesses the additional advantage of low control errors, owing to simplicity of manipulation. T. F. B. (*C. A.*)

PATENTS

45. Cement mill. ANDREW BERGLUND. U. S. 1,426,812, Aug. 22, 1922. A grinder for a cement mill consisting of a cylindrical body of soft material having longitudinally imbedded therein spaced and relatively thick steel bars exposed through one of the opposed ends of the body, the bars being arranged in spaced concentric circles with respect to the axis of the body of the grinder and in spaced staggered reln. to one an other diametrically of the body. C. M. S., JR.

46. Molding and compacting plastic, fluid, powdered, granular, or the like substances. PETER BURD JAGGER. England. 1,428,097, Sept. 5, 1922. In a shaking or vibratory of a machine for molding and compacting plastic, or fluid, or powdered, granular or the like subs., a main vibratory support, means for imparting movement to the support, a platform on the support, the platform having an independent horizontal vibratory movement on the support, and means for imparting positive and controlled horizontal vibratory movement to the platform relatively to the support and while vibrating therewith. C. M. S., JR.

47. Ceramic press. HARRY D. LILLIBRIDGE. U. S. 1,430,019, Sept. 26, 1922. Pressing mechanism including a compression plunger, a feed nut and a rotative screw whereof the screw is free from endwise or traveling movement and acts by its rotative motion to impart sliding motion to the plunger, and a friction drive, coöperating with the screw for imparting rotative motion only thereto. C. M. S., JR.

48. Apparatus for transporting and unloading brick. WILLIAM J. SULLIVAN. U. S. 1,432,638, Oct. 17, 1922. Brick handling app. of the kind described, comprising a framework adapted to be suspended in balanced relation from an overhead support, a plurality of brick engaging fingers normally extending horizontally and adapted to be the lifting, supporting and carrying devices for handling a plurality of brick in stacked relation, together with means permitting an inclination of the brick engaging devices at any time to afford a gravity discharge of the brick, in combination with means acting on the devices to effect a gradual inclination. C. M. S., JR.

49. Apparatus for dehydrating solid substances. F. MAUS. U. S. 1,418,386, June 6. (*C. A.*)

50. Baffled gas scrubber and fume arrester. E. W. LILJEGRAN. U. S. 1,434,301, Oct. 31. (*C. A.*)

51. Apparatus for electrical precipitation of suspended particles from gases. L. W. CHUBB. U. S. 1,433,699, Oct. 31. (*C. A.*)

Kilns, Furnaces, Fuels, Combustion

52. Kilns. ANON. *Brit. Clayworker*, **31**, 319(1923).—"Is it possible for a given type of product to det. *a priori* the best type of kiln to adopt, giving the maximum calorific efficiency?" is the subject of enquiry by the technical commission of ceramic mfrs.

of France. Conclusions drawn from the enquiry are that accurate technical study of kilns and their working, undertaken systematically by French ceram. mfrs., would prove of vast benefit to the indus. in securing economy of fuel and improved quality of goods. It is estimated that such a study would lead to an economy of at least 3 million f. annually, this being a saving of 10% on the value of 300,000 T. of coal used by the ceram. indus. of France. O. P. R. O.

53. New type of French electric furnace. R. Sylvany. *Iron Age*, **110**, 763–4 (1922).—A new type of elec. furnace developed by T. Levoz was used in France during the war for the production of high speed steels. This furnace is a closed crucible with a single opening for charging, making addns., and pouring. The current enters through a large vertical C electrode in the roof. The horizontal section of this electrode is $^1/_2$ that of the furnace crucible. With d. c. this positive electrode is hollowed out and forms a heat reflector. The bottom electrodes are bundles of Fe wires embedded in the hearth and in the lateral linings of the furnace. The lateral lining presents a larger surface than the bottom of the furnace and permits the no. of embedded Fe wires to be increased and their cross-section decreased. Wires of 6 to 10 mm. in diam. are used. The small section metal conductors produce a more uniform distribution of elec. current and more uniform heating of slag. The lateral electrodes are arranged in two superimposed rows, the lower electrodes for fusion, the upper for refining. Current can be switched from fusion to refining electrodes or taken from both rows at once.

L. J. (*C. A.*)

54. The manufacture of electric furnace steels. Johan Leffler and Assar Groenwall. *Rev. metal.*, **19**, Abs. sec., 413–7(1922).—A brief resumé of the Swedish practice. With the introduction of the elec. furnace in 1910–11, the tonnage has been increased from 132 to 75,684 in ten years. The Groenwall Triphase is a popular design and is used extensively. Analyses of charcoal, furnace gases, slags, Lancashire and Bessemer ores and their products are given. Electrodes are 60–70 cm. in diam. and 2–3 m. long; their consumption varies from 15 to 5 kg./ton of metal, according to quality. The power consumption varies from 2000 to 2700 kw.-hr./ton, the efficiency varying from 83 to 92% and increasing with the number of furnaces operating.

W. A. M. (*C. A.*)

55. Melts gray iron electrically. W. E. Cahill. *Foundry*, **50**, 420–1(1922).—An all-scrap charge was melted and refined on a basic hearth under a reducing slag, in an 800-kw., 3-phase, 2-ton Heroult furnace. Si, Mn, and any other desired addns. are obtained from ferro-alloys. On intermittent operation, single voltage, 893 kw.-hrs. are required per ton of steel, and 784 kw.-hrs. per ton of iron. With dual voltage these figures are reduced to 851 and 709, resp. A high quality gray iron of very fine grain is obtained. S varies between 0.03 and 0.06, and P between 0.2 and 0.5%. Very little hearth repair is required; usually 10–20 lbs. of magnesite will suffice.

W. E. R. (*C. A.*)

56. Air preheating for small industrial furnaces heated with water-gas and with coal. Johs. Schmidt. *Feuerungstechnik*, **11**, 6(1922).—The most that can be saved in this way is less than 12%, which will not pay for the installation. The best means of saving heat is by preheating the charge. E. W. T. (*C. A.*)

57. Pot bank firing with petroleum residues. M. A. Granger. *Oil Eng. Finance*, **2**, 477(1922).—Expts. with a special pottery kiln designed to burn petroleum residues are described. An oxidizing atm. must be maintained and the flame must not be of too high temp. so as to cause over-burning and local fusion. The firings were satisfactory, regulation was easy and the expense equiv. to that of a wood-fired kiln.

D. F. B. (*C. A.*)

58. Comments on the paper of A. von Weinberg: "Heat of combustion and work of

dissociation." WALTER HÜCKEL. *Ber.*, **55B,** 2839–43(1922); cf. *C. A.*, **14,** 1332; **15,** 73.—H. finds at least 6 blunders, contradictions, or similar errors in v. W.'s paper. W. P. W. (*C. A.*)

59. Present status of the electric furnace. J. A. MATHEWS. *Blast Furnace & Steel Plant*, **10,** 542–4(1922). E. J. C. (*C. A.*)

60. Hawley electric furnace. ANON. *Metal Ind.*, **20,** 425(1922).—This furnace is designed for melting non-ferrous metals and alloys. Heat is generated by an arc between two horizontal electrodes and reflected on to the charge. The shell is that of a familiar type of oil-burning brass furnace and permits casting directly or through a ladle. It may be charged in horizontal or vertical position. The shape of the cauldron permits of rigid construction, interlocking lining and uniform heat absorption. An automatic oscillating mechanism is provided for mixing. Furnaces of 600, 1200 and 2500 lb. capacity are to be built but only the 1200 pound (150 kv.-amp.) size is now available. W. E. RUDER (*C. A.*)

61. Pilot-light control for furnace electrodes. C. E. SIMS. *Elec. World*, **80,** 1335(1922); Bur. Mines, *Reports of Investigations*, No. **2411,** 2(Nov., 1922).—Automatic control similar to that of the Hall Al cell is secured for a single-phase elec. furnace by employing two ordinary 40-watt W-filament lamps, set upright on a shelf near the meter board, with each lamp connected to one electrode (or busbar). The lamps have a common connection to the metal bath. The brilliancy of the filament varies with the drop in potential between the electrode and the bath. When the arcs are not the same, the difference is indicated by the lamps and if one electrode touches the bath, its pilot-light is extinguished. For 3-phase operation one more lamp is connected to the third electrode. W. H. B. (*C. A.*)

62. The Fiat electric furnace. A. MARTINAZZOLI. *Elektrotecnica*, **9,** 74–9(1922); *Science Abstracts*, **25B,** 239–41.—The Fiat is a 3-electrode, 3-phase, direct arc furnace, operated on 130 v. during the melting and on 75 v. during refining. Separate doors are provided for charging and pouring. The entire fur. rests on two curved rails which allow it to be tilted by hydraulic pistons. A bridge above the roof and supported from the fur. shell is used for adjusting and replacing electrodes and to support electrode economizers. The form of the latter is characteristic of this type of fur. The economizers are formed by a cylinder sliding inside a bell, the 1st. is fixed on the fur. roof, the 2d. on the electrode. These economizers have reduced electrode consumption to less than 3 kg. per T. of steel. The floor of the fur. is provided with a Cu plate embedded in the refrac. and connected to the center of the secondary star, thus allowing the fur. to be put into opern. with a single arc. The fur. assures making without interruption 150 hts. of 5000 kgs. each. Values for power consumption have been found in practice to be 0.6 to 0.7 kw.-hr. per kg. of steel. Cf. foll. abs. L. J. (*C. A.*)

63. Fiat electric steel furnace. A. STROMBOLI. *Chem. Met. Eng.*, **27,** 28–30 (1922); illus. L. J. (*C. A.*)

64. Status of electric furnaces. L. H. KNAPP. *Elec. World*, **80,** 605–7(1922); 9 illus.—A review. C. G. F. (*C. A.*)

PATENTS

65. Kiln. ROBERT T. KYLE. U. S. 1,426,655, Aug. 22, 1922. A kiln comprising a tunnel, a series of heat inlets opening into the tunnel at horizontally spaced points along one vertical side thereof only, and a single heat outlet from the tunnel, the outlet being located at the opposite side of the tunnel from the heat inlets and being longitudinally spaced from all of the heat inlets and in substantially the same horizontal plane therein, whereby to force the heat from the outlets to travel diagonally across the tunnel and through the ware before escaping through the outlet. C. M. S., JR.

66. Recuperator for glass furnaces and the like. WILLIAM MCLAUGHLIN. U. S. 1,432,706, Oct. 17, 1922. In a glass fur., a melting tank having gas outlet flues along its walls and terminating in a horizontal flue, a chimney into which the ends of the horizontal flue converge, air inlet passages extending through the horizontal flue and spaced from the walls of the flue and placed at the remote ends thereof, the inlet passages and outlet flues being in the same horizontal plane, and burners adjacent the inner ends of the air passages. C. M. S., JR.

67. Coal gas collecting main and ascension pipe. C. V. MCINTIRE. U. S. 1,433,634, Oct. 31. (*C. A.*)

68. Gas producer. J. C. MILLER and A. ISLES. U. S. 1,435,322, Nov. 14. A rotating device is mounted adjacent the inner wall of the producer, to grind clinker formed on or near the wall. (*C. A.*)

69. Reverberatory furnace. A. N. JETTE. U. S. 1,435,304, Nov. 14. A cooling coil protects a feed pipe extending through the furnace roof. (*C. A.*)

70. Kiln for firing pottery and other similar articles. C. F. BAILEY. U. S. 1,434,730, Nov. 7. (*C. A.*)

71. Electric resistance furnace. O. A. COLBY. U. S. 1,435,211, Nov. 14. Overheating of electrodes is prevented by placement of a mass of granular graphite or coke between resistors and electrodes. (*C. A.*)

72. Rotary kiln adapted for roasting boneblack or fuller's earth. F. PEITER. U. S. 1,434,023, Oct. 31. (*C. A.*)

Geology

73. Bauxite deposits in Italy. ANON. *Drug & Chem. Markets*, **12**, 223(1923).—There is every probability that a metallurgical plant will be established in Istria, Italy, where large deposits of bauxite occur. A comprehensive report on these deposits giving analyses of the ores has been made by Consul Haven of Trieste which may be secured from the Bureau of Foreign and Domestic Commerce, Washington. O. P. R. O.

74. Kieselguhr in Chile. ANON. *Jour. Royal Soc. Arts*, **71**, 141(1922).—In Tanca Province, Chile, deposits of high-grade tripoli earth have recently been discovered. A French mining engineer gave as his opinion that the tripoli earth in question was of the best quality and especially fine for glazing china. It may also be used in the manuf. of dynamite. O. P. R. O.

75. Oil shale. W. J. WRIGHT. *Canada Geol. Surv.*, Memoir, **129**(1922).—Bituminous shales in New Brunswick are being seriously investigated, the consensus of opinion of the several geologists who have examined the oil-shale deposits of Albert Mines is briefly that here is sufficient oil-shale to supply a large oil-shale industry for upwards of 100 years. O. P. R. O.

76. Feldspar. A. M. CAMPBELL. *Can. Min. Jour.*, **44**, 112(1923).—New deposit of high-potash feldspar, located near Bathurst, Ontario. Deposits are described. Analysis given: Silica, 65.10%; Ferric oxide, trace; Ferrous oxide, 0.11%; Alumina, 21.50%; Lime, 0.11%; Magnesia, 0.06%; Oxide of potassium, 12.81%; Oxide of sodium, 0.58%. Other analyses show potash, 12.61%, 11.66%, and 12.89%, respectively. Sufficient development work has been done to convince feldspar users that this deposit will supply large amounts of marketable feldspar annually. O. P. R. O.

77. Fluorspar. R. G. CARRUTHERS AND R. W. POCOCK. *Canada Geol. Surv.*, Memoir, 3d ed. (1922).—The British sources of fluorspar are by no means exhausted and not only meet home demands but furnish material for considerable export trade. This report contains notes on all the principal mines in which this mineral has been obtained in Britain, and has been brought up to date by personal inspection of the districts in which fluorspar is produced. O. P. R. O.

78. Saskatchewan clays. W. G. WORCESTER. *Brit. Clayworker*, **31**, 330(1923).—Prof. Worcester predicts early development of the clays of the province of Sask.
O. P. R. O.

79. Problems of retarding corrosion. WILDER D. BANCROFT. *Raw Material*, **5**, 267–8(1922).—If a metallic surface is corroded by the corroding medium, the attack must continue so long as the unchanged surface is exposed to the unchanged medium. A cessation of the attack under otherwise changed conditions can occur only when the metallic surface becomes coated with a film which prevents the corroding medium from coming into contact with the metallic surface. The whole problem of retarded corrosion is essentially a question of film formation. E. m. f. measurements are practically valueless. V. O. H. (*C. A.*)

Chemistry and Physics

80. Studies at high temperatures. XV. The vapor pressures of the alkali fluorides. OTTO RUFF, GERHARD SCHMIDT AND SUSANNE MUGDAN. *Z. anorg. allgem. Chem.*, **123**, 83–8(1922); (cf. *C. A.* **16**, 190).—Vapor pressure-temp. curves for the fluorides of Cs, Rb, K, Li and Na are given between pressures of about 50 mm. Hg and 1 atm. The curves are roughly parallel, and the order of metals given above is the order of decreasing vapor pressure at any temp. For any given pressure Rb has a curve about 160° above Cs, K about 80° above Rb, Li about 180° above K, and Na about 30° higher yet. The centigrade boiling points are:

LiF	NaF	KF	RbF	CsF
1670°	1705°	1498°	1408°	1253°

Heats of vaporization, the Ramsay-Young consts., and *critical temps.* (from the Guldberg-Guy rule) are calcd. A. E. S. (*C. A.*)

81. The vapor pressure and sublimation curves for some important metals. J. A. M. VAN LIEMPT. *Z. anorg. allgem. Chem.*, **114**, 105–16(1920).—The formulas deduced in a previous paper (cf. preceding abstr.) are made use of in discussing the vapor pressures and sublimation pressures of the metals W, Pt, Mo, Cu, Sn, Pb, Zn, Ag, Bi, Cd, Sb and Au. (*Ceram. Abs.*, **1** [1], 9(1922).) J. C. S.

82. The National Bureau of Standards. R. S. MCBRIDE. *Chem. Met. Eng.*, **27**, 1159–64(1922).—The organization, functions, personnel, methods and types of work are considered. The relation of industrial research and tech. work to fundamental studies of consts. and research in pure physics is discussed. E. J. C. (*C. A.*)

83. The effect of dissolved substances on the deposition of colloidal particles from a solution by means of an electric current. R. D. KLEEMAN. *Phys. Rev.*, **20**, 272–9 (1922).—Porcelain slip is a colloidal suspension of particles of clay, flint, and feldspar in water (= 70%). When the solid matter is deposited in a mold by electricity a creamy layer forms. If a small amt. (0.1 to 0.3%) of Na_2SiO_3, Na_2SO_4, Na_3PO_4, Na_2HPO_4, H tartrate, Na tartrate, NaOH, or KOH is added to the suspension, a slight pptn. occurs immediately and a gradual process of pptn. (of flint and feldspar esp.) goes on. If more of the clay-flint-feldspar mixt. is added and the mixt. is agitated, the pptd. material redissolves. It requires 60% solid matter to produce the same fluidity which 30% solid matter had previously produced. Elec. deposition from this suspension will give solid deposits instead of semi-liquid ones. An increase in the amt. of the substance added to the slip increases both the fluidity of the suspension and the compactness of the deposit, but successive equal additions are decreasingly effective. Both of these effects are ascribed to a decrease in vol. of the sphere of action of the colloidal particles. This decrease in vol. is due to the influence of the small amt. of substance added to the slip. Since the second deposit is solid it is assumed that the spheres of influence of its

particles are not much larger than the particles. In the untreated slip the sphere of influence must be at least twice the size of the particles. With clay alone, the apparent sphere of action is 3 times the vol. of the particle. Colloidal particles remain in soln. if they sep. after collision, and ppt. if they do not. The forces which cause attraction or repulsion can be expressed in terms of interfacial surface tension. The distribution of particles under the action of gravity is calcd. and expressed mathematically.

F. E. B. (*C. A.*)

84. Losses on ignition and porosity of kaolins, clays, bauxites, etc. A. BIGOT. *Compt. rend.*, **174,** 1232–5(1922); cf. *Jour. Amer. Ceram. Soc.*, **5** [12], 1005(1921).—Bauxite in its natural state does not disintegrate in H_2O, but kaolin and clays do, regardless of whether in the natural state, or after grinding and compressing. The porosity of the test specimens (ground to 200 mesh, moistened and briquetted at 377 kg. sq. cm.) was detd. by the hydrostatic balance method—using a mineral oil of known d. instead of H_2O. The samples were immersed in oil for several hrs., under a bell jar from which the air had been evacuated, to avoid errors due to occluded air. The expts. indicate two new observations: (1) Clays, kaolins, and bauxites which contain more than 14% combined H_2O lose most of it around 300° and before 600°. (2) These substances, which are plastic to varying degrees, harden around 400° before normal dehydration and become agglomerated, and they do not disintegrate in cold or boiling H_2O, or in acid or alk. solns.

A. R. A. (*C. A.*)

85. The plant manager and the chemist. M. L. GRIFFIN. *J. Ind. Eng. Chem.*, **14,** 985(1922); cf. *C. A.*, **16,** 2562.

E. J. C. (*C. A.*)

86. Method of calculating fluidity, surface tension, and reaction (equilibrium) pressure. H. J. M. CREIGHTON. *J. Frank. Inst.*, **193,** 647–55(1922).—By means of an expression precisely similar to the vapor pressure equation of Ramsay and Young, it is possible to calc. the fluidity or viscosity of liquids, the equil. pressure of chem. reactions, and probably the surface tension of liquids. Agreement between calcd. and observed data indicates that the values obtained by this method represent a close approximation to the true values. "The utility of the expression $R' = R + c(T'_B - T_B)$ is evident, for if values of one of the physical consts. are known over a wide range of temps. for one substance (B), and if the value of the const. is detd. at a few temps. for a second substance (A), then its value for the latter can be calcd. over a range corresponding to the range of the known values for the first substance (B). To do this, the values of the ratio $T'_A/T'_B = R$ are plotted against the abs. temps. T'_B, and a straight line drawn through the points. By multiplying a particular temp., T'_B, by the corresponding temp. ratio (read off from the curve), the abs. temp., T'_A, is obtained at which the value of the physical const. of the substance A is equal to that of the substance B at the abs. temp. T'_B. If the line does not run through the points (*i. e.*, if c is not const.), it is probable that the exptl. data are not accurate, or that one of the substances behaves abnormally.

J. S. H. (*C. A.*)

87. Silicates of strontium and barium. PENTTI ESKOLA. *Am. J. Sci.*, **4,** 331–75 (1922).—Considering the wide occurrence of isomorphous sulfates and carbonates of Ca, Sr and Ba, the question rises: Do Sr and Ba under exptl. conditions form such silicates as are known in the case of Ca? For this study the purest SiO_2, Ca, Sr and Ba carbonates obtainable were used. These substances were dried at 150°, weighed, mixed, melted if possible, chilled and crushed, then reheated and ground twice more. The equil. relations were ascertained by the quenching method. Heating curves were run in some cases for the purpose of checking the temp. measurements. Temps. were detd. by a potentiometer and a thermoelement calibrated against the m. p. of diopside and anorthite. Refractive indices were detd. by the improved immersion method of Merwin. The systems $SrO.SiO_2$, $BaO.SiO_2$, $CaO.SiO_2$–$SrO.SiO_2$ and $CaO.SiO_2$–BaO.-

SiO_2 were worked out and the results collected in 12 tables and 12 charts of curves. Crystallographic features are shown in 5 illustrations. Sr and Ba feldspars were found to be analogous to anorthite. L. W. R. (*C. A.*)

General

88. Annual report of the director of the Bureau of Standards, 1922. S. W. STRATTON.—The outstanding feature of the fiscal year ended June 30, 1922, as far as the Bureau of Standards of the Department of Commerce is concerned, was the great amount of attention paid to industrial standardization, to the elimination of waste in the industries, and to the simplification of industrial products. New and important work undertaken during the year was that in connection with building and housing. H. F. STALEY

89. Porcelain bells in Germany. *Zeit. für Instrumentenbau*, January(1923).—The State Porcelain Manufactory at Meissen has succeeded, after repeated experiments, in mfg. a set of chimes of fifty bells, of which the tallest is some 5 ft.; the chime is intended for the use of the Town Church. The tone of the bells, which are tuned after firing, is stated to be remarkably soft and mellow. O. P. R. O.

90. New vacuum drying plant. ANON. *Chem. Trade J.*, **71**, 451–2(1922).—A description of a new type of vacuum drier installed at the works of the *Soc. matieres colorantes et prods. chim St. Denis.* It consists of an air-tight drying chamber contg. trays, a barometric condenser, a Delas steam jet air extractor for maintaining a vacuum in the condenser and drying chamber. This jet discharges into the steam space of the drier and thereby furnishes the heat for drying. The nozzle is simpler and requires less attention and repairs than a vacuum pump. In every case the actual economy is above 50%. L. A. P. (*C. A.*)

PATENTS

91. Damproofing concrete body. FREDERICK G. JORDON. U. S. 1,429,740, Sept. 19, 1922. A damp-proof concrete body, comprising a plurality of perforated sheets embedded in such body, with a bonding strata of cementitious material therebetween, the sheet having alternate openings of the strata, and solid portions of greater area than the openings, the sheets having such relative arrangement as to locate the openings of one sheet centrally opposite the solid portions of the adjacent sheet. C. M. S., JR.

BOOK REVIEWS

Chelsea Porcelain. WILLIAM KING. Published by Charles Scribner's Sons. New York. 1922. $20.

With the present pedagogical and industrial interest in ceramic art development comes specialized and general literature according to past achievements, present activities and future possibilities. The latter invariably closely follows the former.

While the potter himself (meaning the manufacturer, plant official and active worker) has not to date followed closely enough the ceramic literature of his day, there have always been enough interested outsiders or "laymen" to tempt the publisher to speculate on occasional ventures in the ceramic field.

Were it not for this fact, the printed information available to the ceramic student would be meager indeed. Then again, the potter himself is not particularly conspicuous as an author; except for the works of Solon, Burton, Binns and a very few others, the potter has been strangely silent. He is perhaps too much occupied and absorbed in his own field, or he is or has been more or less inarticulate and uncommunicative.

If the present day scientific and technical organizations had existed in the various countries during their highest periods of ceramic development, we would

no doubt have some wonderful practical records in addition to the existing historical data.

Data, however, is so conglomerate, general, and often so unreliable and unauthentic that the selection of a reliable work on a practical subject is an extremely uncertain proposition.

This may be good reason why the potter as a rule is not a heavy purchaser of ceramic literature. The conjectural musings of the ceramic historian are not only unconvincing, they are often ridiculous from a practical point of view. And the clay worker is essentially a practical individual with little patience for romantic theories, no matter how enthusiastic the author might be.

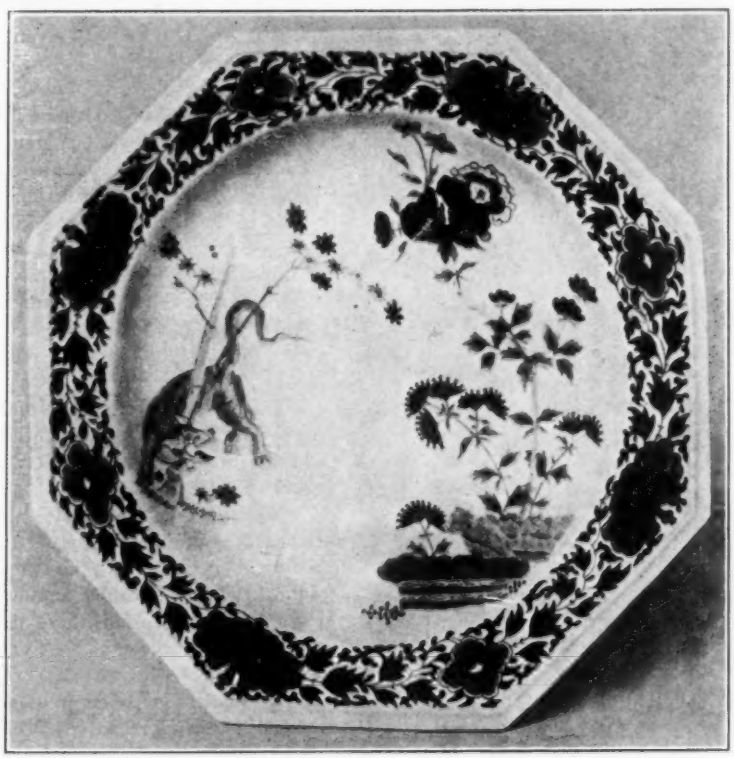


Plate painted in the style of Kakiemon. (Collection of Dr. and Mrs. Bellamy Gardner.)

However, when an authoritative and comprehensive work does appear, it is worth the attention of any ceramist interested in the subject. "Chelsea Porcelain" by William King of the Victoria & Albert Museum is such a work. It adequately but concisely covers the field previous to the founding of the Chelsea Factory about 1745, and then outlines the subsequent developments so far as they are known.

While Mr. King is authority enough for the conclusions arrived at, every source of information is included. To one not familiar with the history of the activity (so far as this is known), this consistent inclusion of references is likely to make the work rather difficult to read. But this should not detract from the interest or value of the book.

The close descriptive detail of the various examples and the consistently pieced together historical evidence represents an enormous amount of patience and interested labor, which will perhaps be appreciated more by the collector and historical student than by the practical potter.

FIG. 1.—Pilgrim bottle of grey stoneware with olive-brown glaze, decorated in high relief showing Hellenistic influence, T'ang Dynasty (in the Victoria and Albert Museum).

FIG. 2.—Caparisoned horse pawing the ground, hollow body made of buff pottery, yellow glaze, T'ang Dynasty (in the Benson Collection).

The chief value of this book to the manufacturer and the ceramic decorator lies in the illustrations which are large and clearly enough reproduced to give an excellent idea of the texture and technique of the example shown. There are one hundred and seventy odd illustrations (a few in color) of clocks, candlesticks, plates, teapots, cups, pitchers, trays, dishes, perfume bottles, figurines and all the various bric-à-brac popular about the time of George III.

The book is an amazingly fine record of an activity about which too little is known. It should be a welcome addition to the factory library where it will be a valuable reference and inspiration to the potter and decorator.

FREDERICK H. RHEAD

The Early Ceramic Wares of China. A. L. HETHERINGTON. Published by Charles Scribner's Sons. New York. 1922. $20.00.

A companion volume to "Chelsea Porcelain" by William King. An able historical account of the pre-Ming wares in which is included an unusually interesting and authoritative description of the technique of the Sung and Yuan wares. (Chapter IX.)

The notes on copper reds will be read with keen appreciation by the practical potter interested in such types.

As the author states in his preface, the illustrations are for the most part selected from good specimens in private collections. This is a good plan because the average student may readily see museum specimens while the private collection is not often available.

The potter will find much more technical and practical information in this book than is found in most historical accounts of ceramic development. The book is a fit companion to "Chelsea Porcelain" and an essential to the library of the up-to-date potter and manufacturer.

FREDERICK H. RHEAD

Grundzüge der Keramik. By DR. W. PUKALL. Verlag von Müller & Schmidt, Coburg. 1922. 187 pp.

Grundzüge der Keramik is a text-book on ceramic subject matter. The treatment is of a general nature and given from a practical viewpoint; but considered in the light of chemical relations.

In an introductory section, a classification of clay products is outlined, of which the main divisions are: (1) earthenware, (2) stoneware, (3) whiteware, and (4) porcelain. Following a general section treating of raw ceramic materials, and of common tests for these, the text takes up the subject matter under the four divisions named above.

The raw materials are considered as (1) plastics, (2) non-plastics, and (3) auxiliaries, such as gypsum, coal, etc. The tests are classified as (1) preliminary and (2) special, or exact. Interpretation of results of examination of elutriation residue are given, and conclusions drawn from results of burning raw test pieces to various temperatures. The method of calculation from weight to volume basis is shown. For further calculations, reference is made to the book on Ceramic Calculations written by the author.

In discussion of earthenware products, types of glazed and unglazed wares are considered, also glazes, methods of glazing and decorating, and the process of burning. Similar treatment of stoneware products is given, but including a discussion of crystalline and decorated crazed glazes. Whiteware products are treated more at length, and problems of preparation and burning are fully treated. Porcelains are discussed as to types, constituent raw materials, preparation, glazing, and decoration. Basic glaze formulae are given, and also effects and strength of colorants. Formulae for different colored glazes and enamels, and for rare metal colors and lusters are given.

E. E. PRESSLER

COMPILATION OF DATA, BIBLIOGRAPHIES AND ABSTRACTS

The SOCIETY is engaged in the compilation of data and bibliographies which are of direct value to ceramic manufacturers and technologists. Abstracts of the world's literature on given subjects are being assembled which will serve as reviews of all the knowledge extant on those subjects. New methods, processes and materials are being investigated.

This is the comprehensive service which the AMERICAN CERAMIC SOCIETY is rendering the ceramic industries.

Through the committees of the Industrial Divisions the work of the SOCIETY is made practical and timely. The problems and needs of each industry are known because the officers and committeemen of the Divisions are, for the most part, in the factories.

With the several Divisions collaborating through the central committees each using the same media for exchange of knowledge, the SOCIETY brings to the solution of the several problems which are common to more than one industry, all the knowledge that applies. In this lies the value of all the ceramic industries joining in the support of this, the only organization devoted exclusively to the promotion of the technical, scientific and artistic interests of the ceramic industries.

The "Collective Index" of papers on Vitreous Enamels, compiled and edited by R. R. Danielson and T. D. Hartshorn of the Enamel Division may be had free upon application to the Secretary's Office.

The "Collective Index" to the first nineteen volumes of the *Transactions of the American Ceramic Society* is also available. Price $1.50.

BULLETIN
of the
American Ceramic Society

A Monthly Publication Devoted to Proceedings
of the Society, Discussions of Plant Problems, Discussions
of Technical and Scientific Questions and
Promotion of Coöperative Research

Edited by the Secretary of the Society Assisted by Officers of the Industrial Divisions

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EDITORIAL

INDIVIDUALISM IN ASSOCIATION ACTIVITIES

Its Responsibilities and Benefits

"American Individualism" by Herbert Hoover, a book of only seventy-two pages, is a wonderfully clean cut and timely message which every American should read. The New York Times says, "This little book deserves to rank, and doubtless will rank, among the few great formulations of American political theory. It bears much the same relation to the problems of the present and the future that the essays of Hamilton, Madison, Jay, and Noah Webster bore to the problems that occupied men's minds when the constitution was framed."

Individualism is the social, the spiritual, the economic and the political principle for which all peoples are striving. It finds a larger expression in American institutions than elsewhere and it is the foundation on which the AMERICAN CERAMIC SOCIETY is builded. Mr. Hoover says that the individualism of America

> differs from all others because it embraces these great ideals: that while we build our society upon the attainment of the individual, we shall safeguard to every individual an equality of opportunity to take that position in the community to which his intelligence, character, ability and ambition entitle him; that we keep the social solution free from frozen strata of classes; that we shall stimulate effort of each individual to achievement; that through an enlarging sense of responsibility and understanding we shall assist him to this attainment; while he in turn must stand up to the emery wheel of competition.

This from the pen of Mr. Hoover is the only formula by which the AMERICAN CERAMIC SOCIETY or any association, trade, technical, scientific, social, political, or religious, can work out its appointed tasks. The reason for this emphasis on individualism in society affairs is given by Mr. Hoover in the following.

> The economic development of the past fifty years has lifted the general standard of comfort far beyond the dreams of our fore-fathers. The only road to further advance in the standard of living is by greater invention, greater elimination of waste, greater production and better distribution of commodities and services, for by increasing their ratio to our numbers and dividing them justly we each will have more of them.
>
> Today business organization is moving strongly toward coöperation. There are in the coöperative great hopes that we can even gain in individuality, equality of opportunity, and an enlarged field for initiative, and at the same time reduce many of the great wastes of overreckless competition in production and distribution. Coöperation in its current economic sense represents the initiative of self-interest blended with a sense of service, for nobody belongs to a coöperative who is not striving to sell his products or services for more or striving to buy from others for less or striving to make his income more secure. Their members are furnishing the capital for extension of their activities just as effectively as if they did it in corporate form and they are simply transferring the profit principle from joint return to individual return. Their only success lies where they eliminate waste either in production or distribution—and they can do neither if they destroy individual initiative. Indeed this phase of development of our individualism promises to become the dominant note of its 20th Century expansion. But it will thrive only in so far as it can construct leadership and a sense of service, and so long as it preserves the initiative and safeguards the individuality of its members.

Every member of trade and technical associations has the opportunity to profit from the experiences and service of their fellow members through organized collaboration in the solving of problems. If operated at one hundred percent efficiency each member of this SOCIETY would profit from the activities of the nineteen hundred and thirty-three other members. The efficiency of this as of every like organization is in direct ratio to the number of individual members who participate; it is dependent upon individual efforts.

No association will be successful unless its management reflects the interest of its members. The degree of this SOCIETY'S success in rendering service to the ceramic industries is dependent upon the service rendered by the members individually. It is on these fundamental principles that the officers and committeemen of the SOCIETY, of the Divisions, and of the Local Sections are working. They are not chosen to do solo parts; they are simply the leaders and agents chosen by the individual members, not as *representatives* in service, but as *leaders* in service.

The success attending the efforts of the officers and committeemen and of the Divisions is proportional to the *active* interest of the individual members. There would be no accumulation of knowledge, no abstracting of the world's literature, no pyramiding of fundamental scientific facts into

industrial practices unless the individual members contribute of their knowledge and time.

There can be no dominance of officers and committeemen in the affairs of a successful society; indeed there is no enduring incentive for one to dominate in a technical society. The guiding incentive of a chosen officer and committeeman should be none other than to render that service which he believes his predecessor and successor in office should render.

The AMERICAN CERAMIC SOCIETY has developed to its present strength and ability to serve because it has emphasized and rewarded individual services. It has allowed full scope to the development of individual ambitions and aspirations, providing the ways and means of acquiring knowledge and of gaining recognition. The SOCIETY offers equal opportunity to each to earn that position in ceramic circles to which his intelligence, character, ability and ambition entitle him, and the strength and character of the SOCIETY in the great service it is rendering is a composite of the character, intelligence, ability and ambition of the individual members in this organized service scheme.

This SOCIETY is a group of persons and corporations, each intent on the best welfare of self, who have learned that self is best served when unselfishly serving with others. Individualism in purpose, service and responsibilities is not sacrificed in any degree in the collective service of a group.

It is not the will of the officers but the will of the individual members that shall be done. It is essential, however, that each member realizes that his will can be done only through service. The *Journal* will be what the individual members will it to be. The satisfactory progress made by this SOCIETY during the past twenty-five years was due to unselfish services rendered by individuals many of whom sacrificed a great deal of time and energy but each of whom found that he served self best when serving others most, for service of one begets service of many. This principle of self service through service to others is now a precept in association work and those who serve are increasing in numbers and in enthusiasm for service.

We have before this emphasized decentralization of activities. We believe in this thoroughly. No officer can, with justice to the members, substitute for those who selected him as their leader. The AMERICAN CERAMIC SOCIETY is growing stronger day by day in service to the ceramic industries because of this decentralization of service responsibilities through Divisions and Committees to the individual members. We believe in individualism in association activities and have learned that benefits accrue to the individual in proportion to the responsibilities he assumes and to the services he renders.

PAPERS AND DISCUSSIONS

RESEARCH—ITS VALUE TO A MANUFACTURING EXECUTIVE[1]

By B. E. Salisbury

In an attempt to discuss this subject, I do not feel that I am going to bring before you anything you do not already know, or that has not before been ably presented, but rather to give you some thoughts that have come to me during the years that I have been interested in the application of research work to some of my own problems.

The last few decades have seen great changes in the manufacturing industry. We are in the era known as big business. Changes of method and management have necessarily occurred. In the history of manufacturing, as well as of other kinds of commercial activity, there has usually been a small beginning on the part of some one man. This man had an idea, possibly much in the nature of a dream or a hope. As time went on and his industry developed he associated with himself other men. There was not in those early days much, if any, organized scientific knowledge. Certain practices, as a result of costly and bitter experiences, came to be recognized as better than others, yet there was little scientific basis for supporting them, and even this was not of general knowledge. In some comparatively few cases such industries were successful and grew to larger proportions, but by far the greater number were failures.

Attracted by the success of these ventures, and not deterred by the failures, others attempted, and in the absence of general organized knowledge, worked in comparative ignorance, and went through these same costly and bitter experiences, some few to succeed, others to fail. So it has been going through all the long years.

As the successful business expanded it became impossible for one man to cope properly with the situation, and so others were gradually trained as helpers, but still there was little definite organized knowledge, and such as existed was carefully guarded by the founder, and those whom he was training. The master still kept his fingers on the situation.

The business continued to develop and expand, and soon came a time when the master could no longer keep in intimate touch with all the operations. There also began to dawn in his mind the fact that, though successful, the business was not on a sure foundation, and that his investment, as well as that of his associates, depended too largely upon his health and continued life. Some way had to be found to carry on after his usefulness came to an end. At the same time he doubtless began to realize the desirability of some definite information of a scientific nature, why certain methods and practices he had worked out were the best, and why others were not desirable; and, still another step, there probably came to

[1] Pittsburgh Meeting, Feb. 12, 1923.

his mind the idea that carefully organized and diligent study and experimentation might reveal methods and practices better than his own.

Being a very busy man, he realized that he could not himself conduct the necessary investigations along these lines without sacrificing time needed in the successful conduct of his enterprise. Consequently he selected some one with qualifications he considered necessary, and, with crude facilities, set him to work at this task. This is my picture of the genesis of the research laboratory.

Business continued to grow, and many of a like nature consolidated. Still the master mind was getting farther away from the details. It being necessary to keep in touch with the operations, the factories were carefully departmentalized, and simple records were started to give him a continuing picture of operations. Cost and efficiency studies were begun. And so today the manufacturing executive keeps in touch with his operations largely through his department heads and his examination of records and statistics. In many of the large industries this is done far away from the scene of operations, which are scattered throughout the country. Considerable time could profitably be consumed in the discussion of the effect of this development on the social structure, but it is not my purpose to go into that subject now.

Today, the progressive industries engaged in manufacturing articles of a nature that are not almost wholly pure fabrication, maintain expensive and well equipped research laboratories, with technically trained men who devote their whole time to investigation of the possibilities of a better product, the study of ways to reduce losses in manufacture, and the search for better and cheaper methods, and also, what is of great importance, the testing of materials, and the product in varying stages of manufacture, so as to make more certain a uniform result. There are some industries in which the producing units are not consolidated under one head, that engage in coöperative research, the extent of which would be beyond the financial ability of any one of the units. In some the technical and research men organize themselves into societies such as our own, and convene to compare notes, and to publish various researches and the conclusions therefrom. This information, being of a public nature, and exchangeable with similar studies on the part of like societies abroad, removes any excuse for starting a business under the handicaps endured by the pioneers. This tends to reduce the waste of effort and capital that would otherwise be experienced.

It is unnecessary to mention the great progress of industry in this country and abroad that has followed these research studies; the constantly improving products, the elimination of avoidable waste, the recovery of by-products and finding means of utilizing them, have combined to give us much of happiness and prosperity.

It is an easy matter to construct a laboratory, and equip it with all the necessary apparatus for chemical and physical research, but the personnel of the research staff is of the greatest importance. It seems to me that research men should above all other qualifications, necessary as they are, be those who are imbued with the idea of service to industry, who will recognize that the experienced men in the shop do know something after all, and that much can be learned from them, and who are in the laboratory to be of assistance to the shop and not to dictate to it. The utmost coöperation between the shop and laboratory force is vital; with it success can be attained, without it failure is inevitable. Therefore in my view the research staff should consist of real men first, and scientists afterwards. This is particularly so with those who in the course of their work come in contact with the shop forces; with others who do purely laboratory work it may not at the moment be so important, but they can never rise above routine work unless they are able to get along without friction with the shop men.

Upon continued and intensified research depends very largely the future of our industries, which are coming more and more into competition with foreign producers for the world's markets. Science applied to industry, coupled with an honest and intelligent labor policy, and high grade business management, will bring industrial success, compared with which, that we are now enjoying will, in future years, seem somewhat insignificant.

Most of the technical problems of the Ceramic Industry are extremely baffling. Difficulties may, and often do, persist for years, before a method is found to correct them. The executive must largely depend upon his laboratory to solve these problems.

One successful operator, when a difficulty arose, used to attack the problem simultaneously, from every conceivable angle. This assured quick results, but he did not know the cause or combination of causes that led to the difficulty; consequently, upon its recurrence, this program was again followed. Obviously, under this plan, no record could be made that would show to others the cause of the particular trouble.

I understand that Edison has done his work more by the process of elimination. I believe it was he who said that "Genius is more perspiration than inspiration." It is said that in his search for a substance that would intercept the X-ray, every known substance was tried until certain forms of natural crystalline zinc sulphide, and later, calcium tungstate, made the fluoroscope possible, and men were able to see bones and obstructions through the human flesh.

Attacking problems of research in this manner, and duplicating at will in the laboratory the effects desired, and also those that are to be avoided, clearly point the way toward the desired end. Careful notes can be made of such a method of attack, and these will show the present executive, or

his successor, the way to get certain effects, or to avoid or correct certain difficulties. This, therefore, puts the manufacturing operation in a technical industry somewhat under control, and safeguards the business.

In addition to its research work, the laboratory may be of great assistance to the purchasing department, in checking up, by physical or chemical examination, or both, the character and condition of the various materials and supplies daily received. This often points to the rejection of some particular lot of material as not being suitable, or according to specifications, and thus saves considerable manufacturing loss. It is highly important that every lot of material entering into the wares produced should, on receipt, be carefully examined and tested, to insure uniformity in the product. The executive must depend upon his laboratory for this work.

Occasionally it is desirable to examine the possibilities of the substitution of one material for another, either to reduce the cost, or to better the product. In order to proceed safely, long and tedious work is necessary, in order that, to gain some desired results, other qualities are not sacrificed. Notwithstanding long and careful laboratory work, it usually takes a shop demonstration on a large scale to insure final results. All of this may take months, or even years, to accomplish, but it is the price that must be paid for progress.

When the executive can delegate to his research staff all of these problems, and the staff and shop work in harmony, he can then devote practically his whole time to questions of finance, sales promotion, labor relations and business possibilities. If his business is large enough these lines of activity are delegated to competent officials, thus leaving him free to keep but a general oversight of the business of which he is the executive head, and allowing time for the planning of greater and better things.

ONONDAGA POTTERY CO.
SYRACUSE, N. Y.

THE ART OF MANUFACTURE AND THE MANUFACTURE OF ART[1]

BY CHARLES F. BINNS

In Alice in Wonderland, Humpty Dumpty says that when he makes a word do a lot of work, he always pays it extra. Under such an arrangement as this the word "Art" must be almost ready to retire on a competency and I, for one, wish it would. Few words have been used with a wider meaning and with less intelligence. The use has ranged from art pottery to tonsorial artist and I am not sure but that the second application is more pleasing than the first. The extensive use of the term makes it necessary to limit or define the sense in which it is to be under-

[1] Pittsburgh Meeting, Feb. 12, 1923.

stood. We are not speaking of the Fine Arts, Painting, Sculpture and Architecture, nor of the Arts and Crafts with their connotation of dilettantism and bric-à-brac. Rather let us think of art as expressing the applied skill of the conscientious worker whether in plastic form, color or line, for it is in these that the ceramic worker expresses himself and makes his appeal for understanding and acceptance. It will not do to fool ourselves and imagine that we possess that which in fact we have not. No progress can be made unless the true condition is realized and candidly faced. We Americans like to believe that we can do anything that any other people can do but this is not always true. We are still confronted by large importations of wares which, rightly or wrongly, are esteemed by the purchasing public as being of higher quality than the domestic product. We must therefore ask ourselves, and must insist upon straightforward answers, first, whether we are manufacturing wares which are in fact equal to these, that is, whether the alleged superiority of imported wares is imaginary or real, and, second, whether we are really interested in producing such wares or are content to go on as we now are, admitting the superiority of the foreign goods but willing to admit it and satisfied if only we can sell, if not an inferior, yet a less ambitious product by the car load.

I do not intend to discuss the strictly decorative wares or tile or scheme goods or anything but the regular table wares of the household. As the matter now stands, we are manufacturing enormous quantities of general ware which is for the most part decorated as open stock patterns. This idea has a potent charm for the manufacturer and the dealer. It has its conveniences also for the consumer who can at any time replace losses without difficulty but it does not make for the excellence which resides in individuality. It affords but little opportunity for the expression of personality in design and denies a place to the fine quality which appeals to the discriminating purchaser. The production of open stock patterns may and probably does present the simplest and most profitable plan for running a large manufactory but the unfortunate result is that it predetermines and stereotypes methods so that the introduction of anything different, even if superior, becomes, if not impossible, exceedingly inconvenient. Let me not be understood as condemning the open stock pattern. There is no reason whatever why good designs should not be set forth in this way and there are good open stock patterns both domestic and imported on the market. The point of my criticism lies in the acceptance of mass production as the most desirable and even the only profitable plan. It lays stress upon convenience and economy rather than upon quality and yet it should be made clear that a good design does not necessarily cost more to reproduce than a bad one.

If my observation has been correct and representative, it tends to show that very few of those who are charged with the production of decorations

have had any training in the principles of design. Indeed very many patterns speak for themselves. They do not satisfy a discriminating taste. Of course, the answer may be that they are not meant to; they are produced for the multitude and must be inexpensive so that the multitude may buy largely. That may be all right if this is our only aim, except that there is discriminating taste even in the multitude, but if we have no other purpose we must not cavil at imported wares.

In opposition it may be argued that the possibility of purchasing abundant supplies of decalcomania prints has relieved the manufacturer from the necessity of employing a designer, but as a matter of fact, the offering of these prints has placed or should place the burden of selective taste upon the buyer or purchasing agent. Too often, apparently, designs are prepared and prints selected for no other reason than that they can be used by the transferrer equally well on every shape and without calling for any skill except a rapid and dexterous fingering. As a matter of fact, we have forsaken the art of manufacture and have become ensnared by the subtle wiles of the manufacture of art.

But art is essentially individual. If it means anything at all it means the expression of an idea, and mass production tends to destroy this. The criterion of fine workmanship is merged in the satisfaction of the manufacturer in seeing that his wares in their passage through the workrooms are all going one way.

If the truth must be told, we have become impatient of taking pains. We are devoted to automatic machinery and the more nearly our employees approach automata the better we are pleased. To some of us the ideal method of making dishes would be a series of endless belts, the work people in long rows each adding a touch to the passing pieces until they are delivered complete to a continuous kiln and from this to the packer.

I am fully aware that the producer of these wares denies that he has any mandate to educate the public and as long as his product finds a ready market he is satisfied. But we cannot remain indefinitely under the protection of a high tariff. Sooner or later we will be compelled to market our wares upon merit and without fear of foreign competition and we shall be wise if we take counsel and look ahead. The Art Division of this SOCIETY believes in preparedness. It aims at placing in every manufactory some person, man or woman, who has undergone a regular training in design and the harmony of color, who is able to judge between good and bad workmanship, who has authority to decide upon the production and selection of decorations, and whose aim is the establishment of the product upon a plane which will reflect credit upon the producer and will appeal to the discrimination of the purchaser.

Two objections, more or less valid, may be advanced against this course: first, a person placed in such a position would probably, in our democratic

passion for titles, be styled Art Director and would be classed as a non-producer, and, second, in consequence of this the expense would be considered as an addition to overhead. Without presuming to dictate to the management of any plant I think we are wrong in regarding a designer as a non-producer and one who selects designs must be at least a potential designer. And further, there is no reason why such a person should not actually produce designs, to be wrought out, if the factory has no department of lithography, by a commercial house. This plan would also have the advantage of providing exclusive decorations. There is a conspicuous lack of individuality in our table wares. Each important European factory has a style of its own and it is not difficult to recognize its product but I do not think that this can be said of us. Back of this there is the important factor of esprit de corps and pride of product. The whole staff should work together in attaining and maintaining an ideal but this is only possible where there is a controlling mind trained to discriminate and to advise. It has of course occurred to you already that persons trained for such work are not at present available and I regret to admit that this is to a large extent true but once let it be known that there is a demand for them and there is no doubt that the supply will be forthcoming. It is of course necessary that anyone undertaking this work should be familiar with the methods of production. This has so far seemed to be the imperative thing that in nearly every case where a superintendent of decoration has been employed the choice has fallen upon a member of the decorating staff. If this is to be the accepted method the person so chosen should be sent to an established school for a thorough course in drawing and design but I venture to think that it is easier to drill a trained designer in the technique of the factory than to teach the sound principles of design to one who has learned his trade at the bench. As I do not want to present a one-sided discussion I will state the opposite view that one who has been brought up in the atmosphere of the workroom can be and usually is selected because of a certain power in dealing with other workers. This is a very important qualification and is difficult but I think not impossible to acquire.

I am not expecting that these ideas will be received with enthusiasm nor that immediate results can be secured. I am trying to look ahead and I ask you to share the vision. There does not seem to be any good reason why a given manufacturer should not select one or two promising young persons and provide for them the necessary training. There are probably local schools of design to which such persons could be sent or if not, it would surely be possible for manufacturers to combine to organize such a school. I recall the potent influence which has been exercised by the Burslem Art School in Staffordshire and by the Lambeth School upon the Doulton Wares.

The whole matter harks back to the question with which we began our discussion. Do we care? Are we satisfied? If the Art Division means anything at all it means that the SOCIETY which gave it birth and which is endeavoring to foster it, believes that it has a part to play and that part can be nothing else than to stimulate and promote the development and, if necessary, the improvement of our product.

It should be feasible for anyone in control of a properly equipped manufactory to create a small department for the express purpose of producing fine wares. Even without any change in body, glaze or fire a great deal could be done and when the first step was taken numerous possibilities would present themselves. It is not likely that such a venture would at first be profitable in cash but it might be made the means of establishing a reputation and anyway it would afford a whole lot of fun. "Oh, well," you say, "we are not in business for fun; we would not be here at all if we did not make money." But I say to you that the man who sticks in his office only long enough to make money enough to have time enough to get away to the country club to play golf is not the successful man. He says in effect, "this job of mine is not a life, it is only a living. If I can make it profitable I will get my fun outside of it." The fact is that if a man does not get any fun out of his daily work he should hunt another job, for the life is more than meat.

We cannot stand still and I repeat that we must not deceive ourselves by the bold advertisement of an advance which is only imaginary. Judging ourselves by ourselves and comparing ourselves among ourselves is no more wise in manufacture than in behavior. Let us at least select the very best examples that can be procured and set them before our operatives, not to be copied but as an illustration of the qualities which are acknowledged to be of the highest class and to which we hope and expect to attain.

NEW YORK STATE SCHOOL OF CLAYWORKING AND CERAMICS
ALFRED, NEW YORK

RELATION OF THE ART DIVISION TO THE OTHER DIVISIONS[1]

BY FREDERICK H. RHEAD

It is impossible to discuss the present and potential possibilities of the Art Division without considering its relation, duties and obligations to the other Divisions.

We limit these possibilities to the extent that we fail to recognize our relationship with the various ceramic activities which include in their organizations one or more of the many types of art or craft specialists.

An interest in a particular Division need not and should not become so detached that its program tends to become the concern of one particular

[1] Art Division, Pittsburgh Meeting, Feb. 13, 1923.

group of specialists to the exclusion of other groups who are more or less involved in the general scheme of production.

The complexities of ceramic work are such that no one group—however well informed and well equipped it may be—can tackle with the full possibility of successful accomplishment its own particular problems without finding itself on ground outside its own range of investigation or research. For instance, the manufacturer of chemical porcelain finds himself immediately concerned with refractories and possibly heavy clay products.

His problems of design, shape construction, modeling and mold construction would be worked out by specialists following the activities of the Art Division.

The manufacturer of architectural faience and terra cotta is, or should be, intimately concerned with the artistic quality of his product—a quality, by the way, which is emphasized or diminished according to the intelligent degree of censorship or direction given to the execution of the work during the planning, modeling, moldmaking, clay-working, selection of color and general technique. A good original design is of course an essential, but a good original design may be altogether ruined by lack of competent direction or execution during any stage of the work.

Competent direction and execution of ornamental or decorated wares of any description are only possible when competent directors and productive specialists are being used, and it is equally obvious that such specialists besides following their own field of research and investigation should in a general way keep well informed of the practical and technical developments in the various fields.

On the other hand, the practical and technical specialists should realize that the decorative specialist is an equally essential productive force possessing a potential field of investigation just as great as that of the practical and technical field.

The Art Division is organized in the interest of artistic and decorative development. The field of research covers shape construction, design, decoration, color development, modeling, moldmaking, applied decoration in various forms, the mechanical decorative processes such as decalcomania, printing, stenciling, etc. These methods may be invented or developed by the practical or technical man, but they must be used with some appreciable amount of artistic expression if truly artistic wares are to result.

The practical activities of the ceramic art specialist cover a wide field, much wider than is generally recognized. Even in a single plant producing one type of ware, there may easily be from three to six men each engaged in a different class of work. Take the average whiteware plant, for instance. There is, or should be, the Art Director, or the man who is responsible for the designs and decorations. There is the modeler, re-

sponsible for the models and relief ornament. There are the painters and decorators. In the English plants where there is still some printing, involving copper plate engravers, there are also the people who do the mechanical decorating, decalcomania; and the gilders, all specialized help, and all doing an entirely different class of work than the specialists working in an art pottery, tile, faience or terra cotta plant.

A designer of table wares may have only the most superficial knowledge of architectural styles, but he must know historic ornament, and he must be able to make highly finished and daintily executed decorations that will be acceptable to the best artistic judgment of the day. If he is called upon to make a design for a plate border in Italian Renaissance, the design must be Italian Renaissance and not a mongrel concoction plainly showing his own ignorance, and advertising his concern to everybody initiated in art as a concern possessing no artistic influence or ideals.

There are manufacturers who may retort that they are not interested in artistic productions, but in popular sales; or in other words, so long as there is no particular public censorship in regard to mediocre design and badly executed decorations, mediocre designs and badly executed decorations will be the rule rather than the exception. But as every business man knows, what will sell today may not sell tomorrow. Just as the manufacturers are learning more about the possibilities in business, so is the general public learning more about quality and style. Even the manufacturer who will not cater to those who know good design admit that there is such a thing as a change of fashion, and that a design that was popular ten years ago may not sell today.

This means that there is definitely such a thing or force as public opinion in such matters, and also that this public opinion does influence the manufacturer to the extent that he changes his decorations every little while. As this public opinion becomes more discriminative, the manufacturer either makes a better product or limits his market to that public which is not so discerning in taste.

The standards of artistic quality do not concern the manufacturer of products alone. They concern the business and domestic life of the nation. We are more interested in Art, or if you prefer, good-looking products than we were twenty years ago. Art and decoration is now being taught in the schools at a cost of some millions of dollars a year. Both the manufacturers and the employees are paying taxes to teach the younger generation an appreciation of art with the result that this younger generation will be educated to the degree where it is likely to turn up its nose at our own wares and buy European and even Japanese productions.

To the manufacturer who retorts that his particular product is selling, one can only reply to the effect that his foreign competitors' product is

selling also, and that a considerable portion of the purchasing public prefers this foreign product to the domestic ware.

For instance, according to a recent industrial report, the foreign imported decorated china ware displaced the domestic product to the extent of about $18,000,000.

We have made such strides in practical and technical clayworking that this preference is not based upon practical and technical excellence. It is based largely on the general appearance of the ware; not entirely, because many purchasers are taught to believe that a foreign article is superior to our own. A dinner service that is known to be French china has an appeal and a sales value that an American china has not yet earned.

But there are many signs by which the progressive manufacturer may gauge the coming popular taste; and these are signs that he can easily recognize. I have mentioned art training in the public schools. The consequent results are obvious. While we are considering the education of the public, let us glance through the pages of a popular weekly magazine. Note the advertisements for American manufactured products. Hundreds of thousands of dollars are spent every year for decorative advertisements for products which in themselves are neither decorative nor artistic. Tobacco is not an artistic product, yet one concern will pay from two to five thousand dollars for a painting or drawing to be used as an advertisement. Soap is not an artistic product, yet within the last ten years, one of the largest soap factories in the world has developed its business by means of its publicity campaigns in which it used carefully designed decorative advertisements.

If a cleverly planned artistic appeal will sell tobacco, soap, etc., it is surely obvious that such products as table wares and other decorated potteries will have a wider appeal and market, if the designs and decorations are planned and executed by competent decorative specialists. A condition where a soap manufacturer will pay from two to twenty thousand dollars for a drawing or painting for advertising purposes, while a manufacturer of art products will balk at an expenditure of fifty dollars for the actual design for a dinner service, re-acts in favor of the soap manufacturer.

The sausage and soap manufacturer go abroad in their million dollar yachts, while the pottery manufacturer stays at home with his nose to the grindstone, and he is lucky if he can escape his desk to the extent of a dozen games of golf in a year.

Even the moving picture industry with its present tremendous popular appeal is paying an enormous salary to an individual, who is engaged simply and purely to raise the standard of the product.

These ideas are not original, and they are not new. They have frequently been more or less forcibly expressed by various prominent Ameri-

can manufacturers of general ware, and further, enough good work has been done within the past ten years to demonstrate the fact that the American potters can produce wares of good design.

But if it requires a Coles Philips, a Maxfield Parrish and a Leyendecker to make designs that will sell soap, tobacco and sausage, then you may be quite sure that it will take an artist equally gifted and skilful to make designs that will sell crockery. And when you do realize this, you will find that your products will have as big a sale as some of the nationally advertised wares.

It is well to bear in mind that it costs as much to reproduce a bad design as it does a good one. And further, the general ware manufacturer is in a much more favorable position than is the art potter and the tile and terra cotta manufacturer. General wares are mechanically decorated. The artistic quality of general ware depends almost altogether on the quality of the original design for the shape and decoration.

If this is good, the resulting product is artistically acceptable, but if the design is bad or not acceptable to the best artistic taste, no amount of technical or practical excellence will make that product acceptable. And again, if the manufacturer is willing to test the market with an acceptable design, he does not have to wait for the much needed industrial art schools plus the five or ten years involved in training designers. We have the best designers in the world today, but these men are engaged, as stated, in the other industries. While the general ware manufacturer may not be able to pay the salary demanded by some of these designers, he at least can pay what would be considered a reasonable price for a first-class design, especially as this first cost is the final cost as far as the quality of the decoration is concerned.

In discussing this question I would like it to be clearly understood that I do not advocate any new or radical change in the present style or arrangement of general ware design. A clever designer can take any artistic "best seller" and make it over in such a way that the uncultivated critic would not recognize the change, while a person who knows a good design would distinguish the difference at a glance. The result of such a procedure would be to include as prospective purchasers not only those who are unable to recognize the fine qualities in decoration, but also those who do. Or in other words, the clever designer is much better equipped to appeal to those who do not understand design than the unskilful designer, while the latter can never hope to interest the ever-increasing number of people who do possess good taste.

To put the case in yet another way, the popular market, so-called, is, as stated, becoming more fastidious. It is both able to recognize and demand better designed clothes, furniture, jewels, moving pictures and automobiles. Even Henry Ford is once in a while compelled to improve

the appearance of his "Tin-Lizzie" if he is to hold his market. So it is, I think, reasonable to assume that the manufacturer who makes a business of producing decorated wares will before long produce wares that will seriously compete with European products.

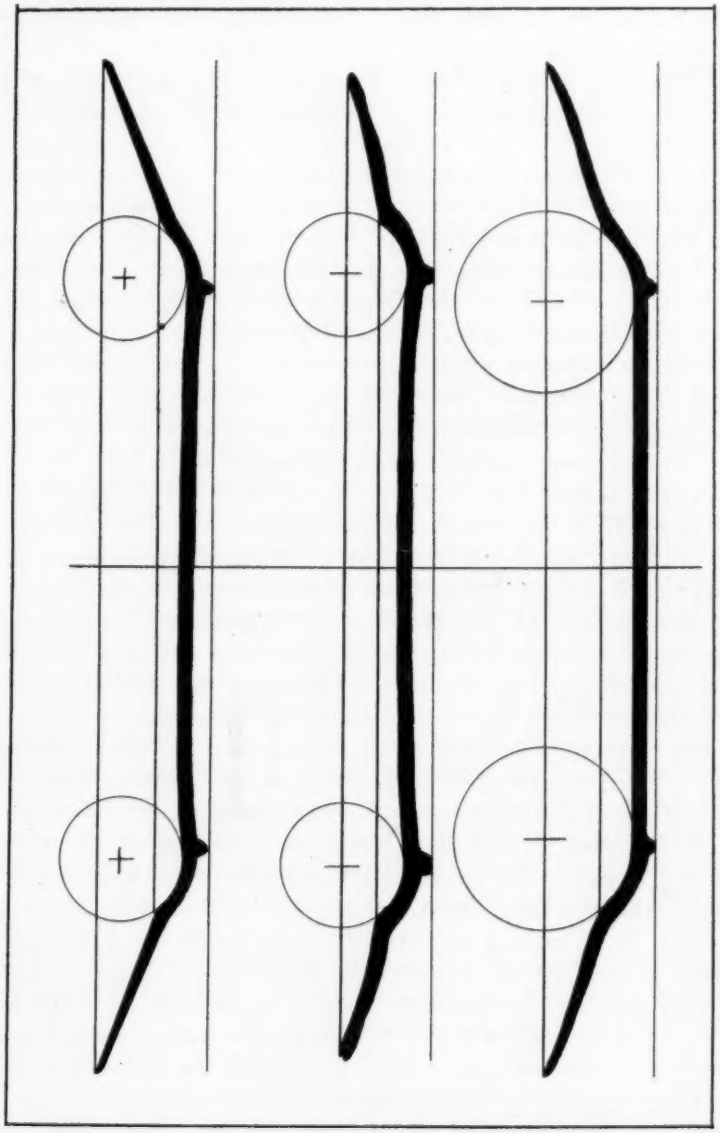

FIG. 1.—Sections of plates measured from actual examples. The finished shape is seldom, if ever, absolutely under the control of the designer or modeler, because it is always subject to a variation both in regard to size and shape, which in the absence of a properly defined specification and variation allowance cannot be accurately estimated.

While there has been considerable research work in connection with the technical branches of general ware practice, there has to my knowledge been little or no real research in either shape construction or decoration.

It is even quite possible that few manufacturers and even ceramic designers know what such research involves.

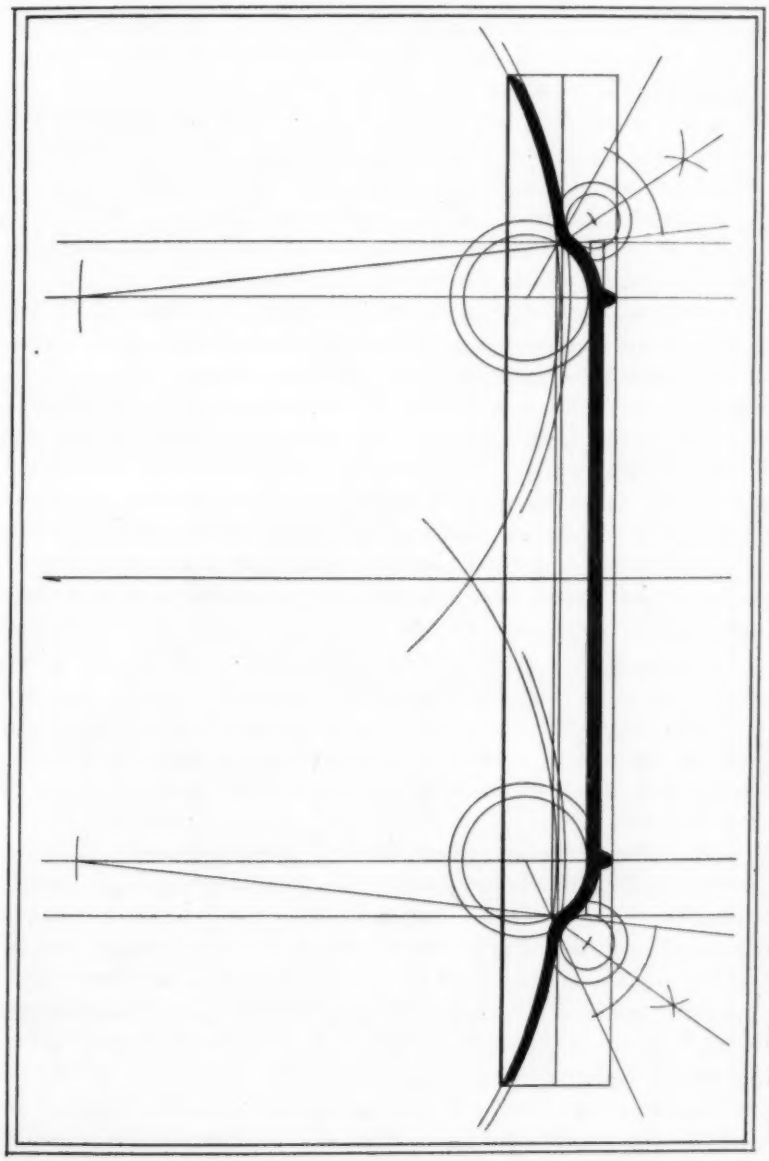

FIG. 2.—Plate section based upon a definite measurable construction. If a section of the finished plate be measured and checked up with this working drawing, the exact degree of variation can be determined, supplying data which would contribute to a more accurate shape control.

For instance, take the average nine-inch dinner plate. Consider shape construction first. Aside from the general appearance of a nine-inch plate, how many manufacturers and shape designers know whether the base of

the plate should be five, four, or six inches; or the most practical height and width of the foot of the base?

What investigation has been made to determine whether the body of the plate inside the rim should be modeled exactly flat, or if not, just what degree of concavity or convexity should be adopted to prevent the inside of the plate from rising or sinking in the middle while it is being fired?

Just what is considered to be the most desirable width for the rim of the plate and the most acceptable height of the rim from the base? In those plates which are placed flat in the sagger, how much is allowed for the settling or dropping for rims of various width and height?

I am speaking from a purely practical point of view with some consideration of the preventable losses due to warping, etc.

Has there ever been a systematic study of sections of plates made by the factories of various countries, and is there a general ware plant in this country where such an investigation has been worked out?

In those factories producing vitreous or feldspathic porcelain, I believe such an investigation would result in determining a plate construction which would minimize warping during the drying and firing.

So far as mold construction is concerned, this branch of the activity is generally left to the judgment of the modeler and mold-maker, and it is a question if there has ever been a serious systematic study to determine the most suitable thickness, shape and type of molds for various articles to be cast, pressed or jiggered. I do know of one or two isolated instances where the standardization of thickness of the mold for articles of various sizes has resulted in the saving of carloads of plaster, and also in increased shop efficiency. In addition, a large waste of plaster has been practically eliminated by the simple means of providing the mold-makers with a round or square iron frame into which surplus plaster has been poured to be used for setters.

There is little doubt that increased efficiency and a big saving of plaster would result if well planned working drawings or blue prints were used by both modeler and mold-maker. For by this means the model could be closely checked up before it was turned over to the mold-maker and the exact method of mold-making would be established and controlled. Then there is the research work covering investigation in connection with the decoration of the plate. Assuming that a standardized nine-inch dinner plate had a one and three quarter-inch rim, and that the curve to the inside of the plate was based on a one-inch radius. This would leave approximately five inches for the center of the plate, so the available field for decorative purposes consists of a circular border nine inches in diameter and one and three quarter inches wide; a narrow curved circular border, and a flat circular space in the center of the plate five inches in diameter.

Considering the possible decorative arrangements, we find the following combinations:

1. A flat circular panel five inches in diameter surrounded by a narrow frame or border and a wider border occupying the entire rim of the plate.
2. A flat circular panel five inches in diameter surrounded by a narrow frame or border, but with no border on the rim other than the gilt or colored edge.
3. No decoration in the center of the plate, a border covering the entire rim framed by a narrower border arranged around the inside of the curve.
4. A border occupying the entire rim of the plate, but no decoration around the curve or in the center of the plate.
5. A border occupying less than the available space on the rim of the plate.

While those quoted are the possible arrangements, the majority of present day dinner ware designs consist of a border occupying all or a portion of the outer rim of the plate.

In considering the possible decorative motive, we have two broad groups:

First, naturalistic decorations of floral and other natural forms arranged and interpreted much as they appear in nature, and secondly, conventional decorations, or natural forms converted into ornament more or less abstract or symbolic in style. As each country and period developed its own individual style, we have at our disposal a wide range of distinctive historic and modern decorative types, the most notable, or at least the most used, being possibly the Grecian, Italian and Chinese. The Persian, Japanese and French have also been prolific sources of inspiration.

The modern designer, however, has struggled to develop a style that is entirely original, but with no particular result to date except the more or less mongrel interpretations which can easily be traced to their original sources. This is not the place to analyze the various types and styles of ornaments. It is only necessary to state that the competent designer must know these types, and that each progressive plant should have filed for reference purposes either good reproductions or actual examples of these various types or styles.

As fashion changes, and as there is evidence of the coming of a particular fashion or style, the manufacturer or the designer can select one or more decorative styles for his new productions. In gauging the possibility of future markets, these defined conditions should be closely observed.

Often these are neglected for more superficial signs. For instance, the manufacturer will take close cognizance of new importations and try as closely as possible to follow them.

Would it not be a more rational method for the manufacturer to follow closely the prevailing decorative styles in other industries? The textile,

wall paper, carpet and furniture interests through their big industrial exhibitions define to a great extent what the coming popular style will be. The various fashion magazines are valuable sources of information. Certain authentic decorative types are always more or less marketable, but there is generally a predominating style and color which appeals for a period of a year or so to a great popular market. Consequently an approximate estimate of this condition is pretty sure to result in a popular seller, which is what we are all after.

But the point I am trying to make in connection with the decorative research is this, that unless a chief designer or art director is constantly investigating these conditions, collecting authentic examples or reproductions of examples properly classified and filed with data covering costs, markets reached, sales, etc., and supplementing this data with carefully worked out drawings based upon the present acceptable space combinations given, he will never be any better able to interpret the market than he is now.

The efficient art director should not only be concerned with the production of half a dozen or so different patterns a year, a group selected say from twelve to twenty designs, but he should have scores and hundreds of research or development drawings, showing variations of different acceptable styles. To an expert designer, the making of an actual drawing is but a matter of an hour or so. The most finished design for a dinner plate can be made in about half a day. So far as the actual drawing is concerned, little labor is involved. But this finished design may be the final development of hundreds of previous sketches.

The trouble with most of our ceramic designers is that they do not draw enough. When only a dozen or so sketches a year are asked for, a drawing begins to assume the proportions of an undertaking instead of a casual incident in the course of a week's work, and the designer, because of his lack of practice, does not acquire the facility of execution, or knowledge of the historic styles that are the stock in trade of the commercial designer in other fields.

A plate design seems a simple undertaking, but assuming that both the shape and design are finally developed, there are a hundred possible color schemes, even if only two or three colors are to be used. While a simple border may not show the amount of work involved, a perfectly designed plate with a well balanced color scheme may easily be the result of work covering a period of time of a year or more.

Consider the amount of work involved in connection with the development of a single body and glaze, and then consider how little true research work is done in connection with decoration and color arrangement.

The Art Division is definitely interested in design and decoration in relation to the general ware industry, and in addition, in constructive

criticism such as is here offered with due respect for the problem and the conditions involved. We hope to arouse the interest of the whiteware manufacturers to the extent that we can present contributions to the *Journal* covering various phases of decoration and shape construction development.

I am conscious that many of the points raised in this paper require further elucidation and elaboration, and when the opportunity offers, this will be done.

At this time it is enough to state that the Art Division realizes and recognizes the need for important constructive work in the interest of the whiteware industry.

This recognition extends also to other branches in the ceramic field. We have a rapidly increasing market for art, tile, faience and terra cotta wares of a class that will compare favorably with the best work in marble and bronze. And within a few years at most the work of the potter will be exhibited side by side with the work of the great artists of the country.

But we cannot expect this privilege or the increased business that will result from such an advance until our draftsmen, artists, craftsmen, decorators and modelers are properly equipped and efficiently directed. And in regard to the latter, the direction does not involve only the active head of the department, it involves the manufacturer himself, or the business head of the organization. It is not, of course, necessary that the manufacturer or general manager be a decorative process man. But it is essential that he has an appreciation both for the finished product and the difficulties involved in its production.

As previously stated, there is a wider field for investigation in connection with art wares, tile, faience and terra cotta than in the white utility wares, because there is a wider range of decorative processes and a larger practical field. For this reason, the Art Division is interested in such activities as:

1. Industrial schools.
2. Practical clayworking processes relating to various types of ceramic ware.
3. Draftsmanship in connection with shape construction.
4. The ornament and architectural styles of various countries and periods.
5. Ceramic design.
6. Decorative ceramic processes.
7. Color standardization.
8. Supervision and direction in educational and industrial ceramic art activities.
9. Educational programs as outlined by Mr. Boudreau.

To mention but a few broad subjects of vital concern to many of those interested in the other Divisions.

Life is so short and the complexities and intricacies of ceramic work so involved that no one person can ever hope to know but little about it. For this reason, if for no other, those who can in any way contribute to our present knowledge should do so, not only because they add to the fund of total experience, but also because they themselves will benefit by participating in the general development.

American Encaustic Tiling Co.
Zanesville, Ohio

HISTORICAL SKETCH OF THE MANUFACTURE OF PLATE GLASS IN AMERICA[1]

By C. E. Fulton

In a brief history of the plate glass industry such as this, it will only be possible to describe the early attempts at plate glass manufacture and touch upon the outstanding developments which have been achieved.

The first attempt to introduce the industry was at Cheshire, Massachusetts, in 1850. This plant was later removed to Brooklyn, New York, but the company soon failed. In 1865, Theodore and James Roosevelt of New York formed the National Plate Glass Company and erected a plant at Lennox, Massachusetts. Machinery was brought from England, and although for a while this Company was more successful than the first organization, it also met with disaster and was discontinued in 1871. After this date further attempts to establish the industry in this country are connected with Captain John B. Ford, and a brief biography of Captain Ford and his various enterprises will be of interest.

He has been termed the "Father of the Plate Glass Industry in America," and when it is realized that he was the first to make a satisfactory product in this country at New Albany, Indiana, and the first to put the industry on a paying basis at Creighton, Pennsylvania, he is rightly deserving of this title.

He was born November 11, 1811, in Danville, Kentucky, and before engaging in the manufacture of plate glass had an interest in a number of diversified industries. The management of a store, manufacture of safes, saddle-making on a large scale, building steam boats, commanding Ohio River steamers, and an attempt to make glass sewer pipes were some of the activities of this versatile man.

At the age of 58 he became interested in the manufacture of plate glass, and, after studying the methods used in the previous efforts in America and the methods relative to European practice, Captain Ford with his brother-in-law, Washington Irving DePauw, built a factory at New Albany,

[1] Received Feb. 27, 1923.

Indiana, in 1870. As in the earlier attempts, the machinery was purchased in Europe, but before it arrived the buildings were destroyed by fire. Undiscouraged, new and larger buildings were erected to take their place, and New Albany has the distinction of being the first place in America where a satisfactory quality of plate glass was made. This venture met with some success, but in the language of the census report for 1880 "it had to undergo the reverses that seem the fate of all plate glass houses in this country." A second factory was erected by Captain Ford at Louisville, Kentucky, in 1873, and a third at Jeffersonville, Indiana, about 1875. A fairly satisfactory quality of glass was produced but they also failed after operating for a few years.

Before continuing with Captain Ford's efforts, it should be stated that the American Plate Glass Company was organized in 1876 and a plant erected at Crystal City, Missouri. One year later the corporate name was changed to the Crystal City Plate Glass Company with the late Hon. Ethan Allen Hitchcock as president. This plant has since been entirely rebuilt and is one of the largest plants of the Pittsburgh Plate Glass Company.

Some time later, Captain Ford became associated with Mr. John Pitcairn of Philadelphia and formed the New York City Plate Glass Company. The name was changed in 1883 to the Pittsburgh Plate Glass Company and a plant built at Creighton, Pennsylvania. This plant is still in existence and is known as Works No. 1 of the Pittsburgh Plate Glass Company.

Between the years 1885 and 1895, Captain Ford was instrumental in having plants erected at Tarentum and Ford City, Pennsylvania, the latter place being named in his honor. He died at Tarentum in 1903, at the age of 92.

Prior to 1880 not a square foot of plate glass had been made in the United States without financial loss to the manufacturer, but according to government reports the cost in 1884 was only one-half of the cost previous to 1879, due largely to the proficiency attained by the workmen. The same report gives the number of men engaged in the industry as 956, and the annual production at a little over one and one-half million square feet.

In all these early factories the European methods were used and European practices closely followed. The method in general was to fuse the raw materials in pots or crucibles placed in regenerative furnaces. When thoroughly melted and fined, the molten glass was poured on a cast iron table and rolled into a plate, after which the plates were placed in an annealing oven or kiln to remain for several days and the temperature was gradually decreased to a degree where the glass could be handled. The glass at this stage was about one-half inch thick and contained many surface irregularities and imperfections. These rough plates were drawn from the annealing kiln and examined; after cutting to eliminate the more

glaring defects, they were sent to the grinding department. In this department they were laid in plaster of Paris, upon square or octagonal shaped tables and revolved under iron shod runners, while sand ranging from quite coarse sizes to very fine was thrown on the glass until a flat surface was obtained. The plates were then turned over and the process repeated until both sides were finished or ground, the time required to grind each side being from eight to twelve hours. The plates were then removed, cleaned and again imbedded in plaster held by wooden frames, and rubbed one against the other by an eccentric motion, emery being worked in between the surfaces until a finely ground surface was obtained. When both sides had been smoothed in this manner, the plates were sent to the polishing department for final finishing. The polishers comprised square wooden tables upon which the glass was again laid in plaster and felt covered blocks were lowered upon the glass and the surface rubbed by a sliding motion until the desired finish was obtained. As is still the case, rouge was the polishing medium used. After this operation the glass was sent to the ware room where it was examined for defects and cut into size.

The modern plate glass plant still follows the above outlined procedure, only upon a much improved and more efficient basis. Very few changes have been made in the composition of plate glass or in the materials used in reducing the rough uneven surface to the familiar highly polished plate. However, various proportions of the ingredients used in the plate glass batch have been studied and better combinations have been adopted which produce glass of a superior quality. The various ingredients entering into the batch are subjected to chemical analysis and a much higher standard of purity demanded than was formerly the case.

Enumerating the major improvements which have been made, the first on the list is the grinding and smoothing operation. In 1889, at Crystal City, the English smoothers were abandoned and all the glass thereafter ground and smoothed on grinding machines. This necessitated changing the design of the old machines and round tables were substituted for the square or octagonal type. The effect of this new method was to reduce the grinding or smoothing time by over 50% and led directly to an improvement in the method of polishing. The table or deck on which the glass was laid formed a part of the old machine and it was therefore idle while the glass was being laid or turned over. As one hour was required to lay or turn over a table, and as this operation was necessary several times during the grinding, smoothing, and polishing, the time when the machine was idle was an item of considerable importance. In order to overcome this drawback, machines were designed, about the year 1900, with a removable table or deck made to fit any grinder. A number of extra tables were provided so that no machine would be idle.

Rough glass is now laid on the table, it is placed under the grinder, and when one surface is ground and smoothed, the table is transferred to a polishing machine to have the same surface polished. In the meantime one of the extra tables has been placed in the grinder and the machine is idle for only a few minutes. After the ground side has been polished, the glass is turned over and the reverse side ground and polished in a similar manner. This method requires handling the glass three times during the finishing operation instead of nine times which was necessary in the early factories. Present machines are idle for only the few minutes required to take out a table and replace it with another.

The old type English and Belgian polishing machines were also replaced by the circular type so that the tables or decks from the grinding machines could be placed in a similar machine equipped with polishing blocks. A study of the weights and arrangement of the polishing blocks, and the consistency and preparation of the rouge, together with the determination of the proper pressure per square inch and the most efficient speed to rotate the grinder and polisher tables has greatly shortened this operation.

Numerous minor improvements, such as the proper grading of the sand and emery, and the advent of electrically driven machinery has contributed to the success of this operation. Prior to 1889 when the first of these improvements was introduced, about ten days was required to produce a polished plate of glass from the raw materials. In the modern plate glass industry, it is now possible to deliver a mirror to your home, or put a plate glass top on your desk, in less than thirty-six hours after the sand, lime, and soda are placed in the crucible.

Another radical change or improvement was effected in the casting or melting department about the year 1900 when a continuous annealing leer was built at the Floreffe, Pennsylvania, factory of the Pittsburgh Plate Glass Company. The leer is a long low tunnel connected to a series of ovens (usually five). Immediately after the plate is rolled, it is placed in the first or hottest oven and at regular intervals is moved into the succeeding ovens until it reaches the runway or leer proper, where it is automatically carried on steel bars to the cutting table at the delivery end of the leer. The temperatures in the ovens and leer are so arranged that the glass is slowly cooled from 1200°F to 100°F. By this process only a few hours are required to properly anneal a plate, compared with four or five days in the old type kilns. This leer method of annealing glass was fully developed in America, and it was not until recent years that it was adopted by the European industries. This development increased the efficiency of the casting hall, in that the casting table is now stationary instead of being moved on tracks to the entrance of each annealing kiln, as was the former practice. In this department electricity has also played a prominent part and many devices have been developed for handling the

pots of molten glass and the large rough plates. Furnaces have also been improved and enlarged so that single rough plates containing 450 square feet of glass are now produced.

Within the last ten or twelve years the pot house department has received more attention, and various improved methods have been introduced in the preparation of pot batch. The individual clays entering into the batch have also been studied and while at one time it was thought necessary to use a certain amount of pot clay from Germany, it has now been proven that superior batches can be made using American clays exclusively. The process of building pots has not undergone any material change, although it has been proved practical to make pots by the casting process. In former years it was not uncommon to lose a large percentage of pots during the drying period, but by careful attention and careful control of temperature and humidity conditions, very few pots are now lost during the drying process. Further developments in the drying process have demonstrated that pots can be safely dried in much less time than was formerly required. The size of the unit of production has gradually increased and necessarily the pots have kept pace. In some factories large oval pots are now used, which produce a plate of glass containing 450 square feet.

Summing up briefly the outstanding features, the developments of plate glass industry have been:

1. Increase in all departments of the size of the unit handled.
2. Reduction in the annealing time from four days to a few hours.
3. Completing the grinding and polishing operation in a few hours instead of several days.
4. Extensive changes in the general plant equipment, so that a modern factory bears little resemblance to the plant built fifty years ago.

As late as 1900 with the equipment then in use it was not possible to make and handle a plate larger than 200 square feet, while now plates containing 450 square feet are produced. Instead of giving employment to 956 men and producing one and one-half million square feet as in the year 1884, the potential capacity of the American factories today is approximately one hundred million square feet, and employment is given to 20,000 men. French plate has ceased to be considered as the highest grade of polished plate glass as the American factories produce glass that is second to none in quality. A considerable amount has been exported and is able to compete on a quality basis with European glass.

And now the method of making plate glass is confronted with a new revolutionary process which promises to supercede practically every feature of the existing method, both as to process and equipment, but it is too early to give any details.

RESEARCH DEPARTMENT
PITTSBURGH PLATE GLASS CO.
CREIGHTON, PA.

INVENTIONS AND PATENTS[1]

Some Phases of the Patent Law

By George E. Middleton[2]

Books have been written on the Patent Law. It is a broad subject and has many phases. In this short paper I cannot do more than touch upon it. Yet, having been a ceramic engineer myself, and, in my profession as a patent lawyer, coming in constant touch with engineers, I believe that I understand at least some of the problems with which you are faced in your relations with the patent system, and hope that I can offer a few profitable suggestions which may assist you in approaching these problems.

The mind instinctively associates the word "patent" with the word "invention." And this is quite right. For under our system no one may apply for a patent who has not invented something. But the word "invention" is too commonly associated with the word "genius"—evoking the image of the printing press, the cotton gin, the steam boat, the telegraph, and other classic and epochal inventions. But invention is only rarely like that. It is the multitude of little improvements, of improvements upon improvements, the rank and file of invention, that keep the wheels of progress turning. Then, too, we like to clothe invention with mysticism. In our fancy, we see it spring full-formed from the inventor's brain, like Minerva from the brow of Jove. Sometimes this is so, but not often. The worth-while inventions of today are the products of hard thought, developed after patient research to satisfy a recognized demand. The inventor today is the man in the shop, the engineer, the scientist—the man who knows his art, its deficiencies and its needs.

It has been these engineer-inventors who have made modern ceramics what it is and it is these men who will carry it still further. It is needless for me to speak of the progress of the past twenty-five years, except to emphasize the predominant part which your inventors have taken in it, and still more to emphasize the part which they must inevitably take in all future progress. And when I say "they," I really mean "you." Whether you realize it or not, you are inventors, actual or potential.

Of course, not all the improvements which an engineer makes are inventions. No one has yet formulated a definition of invention—and I cannot here discuss the several negative tests which are applicable—but it may safely be said that a large proportion of these improvements are inventions and are patentable; certainly a much larger proportion than the engineer commonly thinks. Believe me, then, when I say that, whether you know it or not, you are inventors. You are committed to invention.

[1] Pittsburgh Meeting, Feb. 12, 1923.

[2] Member of the New York Bar.

Now the Constitution empowers Congress "to promote the progress of science and the useful arts by securing for limited terms to inventors the exclusive rights to their discoveries," and Congress, acting under this power, has from time to time enacted legislation which forms the basis of our patent system and under which any inventor may, subject to certain restrictions, apply for and receive the exclusive right to his invention or discovery for a term of seventeen years. I suspect that many of you are not enthusiastic over our patent system. I well remember an editorial in the *Journal* not many years ago, which, to say the least, was not fulsome in its praise. Be it so, nevertheless this patent system is so interwoven into our industrial fabric that no industry is untouched by it, and no industry can afford to ignore it, least of all an industry which depends for its very existence on the brains of its engineer-inventors.

Hence, being exposed to the system, willy-nilly, and accepting it as the established order, what are you going to do about it? For you must do something.

A patent is, in effect, a contract. The nation says to the inventor: "If you will invent and disclose your invention to the people (observing certain prescribed formalities), teaching them how to use this new thing which you have conceived and developed, then you shall be granted the right to exclude all others from making, using, or selling it for a period of seventeen years."

The acceptance of this offer is not at all obligatory. You may accept it or reject it, but you cannot weigh the question forever. Within a certain time you must choose. It is imperative. You must bear in mind, too, that the offer is open to all. If you do not accept it, another may. What I shall try to do in this paper is to tell you briefly, not what your decisions should be, but rather what the consequences of those decisions will be. This is, indeed, of vital importance, not only to you as inventors, but to those for whom you are inventing.

Having made an invention, there are two matters to be considered, (1) how can you exclude others from the use of it, and (2) assuming that you do not care for a monopoly, how can you prevent others from obtaining a monopoly in it, excluding you and the public you wish to benefit?

Obtaining a Monopoly

There are just two ways of excluding others. You can

(*a*) Keep your invention a secret, or

(*b*) You can accept the nation's offer, make a full public disclosure, and patent it.

Secret Use

Let us first consider the advisability of keeping it a secret. Having made the invention, it is yours. You have a common law right to it and the

courts will protect you in the exercise of that right against one who obtains it from you by fraud. A patent in no sense gives you the right to use your invention, for, subject to the rights of others, that is your natural right. Thus you may enjoin to secrecy those who work with you or for you in the exploitation of your invention, provided always that the secrecy is genuine. But your position is a precarious one. In the old days, glaze formulae were handed down in secret from father to son and guarded jealously. That was possible then. Today it would be difficult. And once your secret has been discovered by another, by independent invention, by deliberate analysis of your product, or by well thought out scientific guessing, your secret is gone forever, and you have no redress. And once having definitely decided to operate in secret, you have renounced forever your right to apply for patent protection. Thus when discovery becomes imminent, you may not accept the offer of a limited monopoly which, in the first instance, you rejected. Another point: you must actually use your invention. If you discard it you will be held to have abandoned it, provided your actions are consistent with no other course, and a later independent inventor may not only reinvent it, but may get a patent and so prevent your later enjoyment of what was once your own.

In concluding this brief discussion of secret use, it may be pointed out that many inventions from their very nature cannot well be practiced in secrecy, hence if you desire to enjoy a monopoly in the practice of such inventions, the only course open to you is to patent them. Which brings us to consideration of that other method of obtaining a monoply.

Patenting

Our patent laws provide for the grant of patents to original and first inventors only, and between two or more original and independent inventors, the one first in time will prevail. And between an inventor and a public use or published description of the same invention, the former will prevail only if his invention is prior to the use or publication. Hence, the question of priority is of utmost importance to those seeking patent protection, and the question naturally arises—when is an invention said to be made?

The inventive act consists of two parts, one mental, the other physical; one the conception of means whereby the desired end can be attained, the other the actual embodiment of this conception,—reduction to practice, as the expression is. In the contemplation of the law, an invention is not complete until it has actually been reduced to practice, and if the inventor proceeds diligently to test out his conception, giving it a local habitation as well as a name, the date of his invention is the date of his conception. But inexcusable delay in reducing to practice may deprive the inventor of the right to carry the date of his invention back to the date of conception.

It is thus incumbent upon the inventor who hopes for a patent not to dream too long over his idea.

It is also incumbent upon him to keep records so that in the event of a contest, either with a rival inventor over the question of priority, or in a suit for infringement, he will have evidence at hand to prove his date and his diligence. It is not enough that your footsteps should echo and re-echo down the corridors of time. Clear and unmistakable footprints on the sands thereof are much more to the point. The existence of an inventive concept locked in the inner consciousness of the inventor is absolutely unprovable. As soon, therefore, as you conceive an invention, you should get it out of your system in some objective form, such as by making a written description of it or a sketch. Or you should explain it to someone who is capable of understanding it and who would testify to the disclosure if necessary. Indeed, it is well to do both of these things. Have someone write on the drawing or written description that he has read it and understands the invention. Then have him sign this statement and date it. Records should also be kept of the subsequent experimental work in reducing the invention to practice. In your research and works control laboratories, the daily laboratory records are usually adequate. In every case, however, it is well to have more than one investigator familiar, at least in a general way, with each investigation and development so that the testimony of the inventor can be corroborated.

There is a mistaken notion prevalent among inventors that if a patent is to be obtained, it must be applied for as soon as the idea has popped into the inventor's head. This is not so. On the contrary, it is much better to wait until experimental work has indicated not only the feasibility of the idea, but the probable lines of development. And as long as this reduction to practice is diligently pursued, no rights are lost, and it may be, and usually is, pursued in secret with no danger that the right to a patent will be held abandoned. As stated before, the effective date of your invention is the date of conception when followed by diligence in reducing to practice. It may happen, however, that actual embodiment of the invention may call for a large outlay of capital, or there may be other reasons why actual reduction to practice cannot be undertaken immediately. In such a case, the filing of an application is advisable, this application being considered a constructive reduction to practice, and in most cases satisfying the requirements for diligence.

It is not even imperative that an application be filed immediately after the invention has been completed. However, after the completed invention has been in public use, or on sale in this country for two years, or described in a printed publication for two years, be that publication here or in the uttermost parts of the earth, a conclusive presumption of abandonment to the public arises, and thereafter the right to apply for

a patent is absolutely lost. The law does not favor him who sleeps upon his rights and after the invention has been completed and proved, an application should be filed without undue delay, certainly within two years.

How to Prevent Others from Obtaining a Monopoly in Your Own Invention and Excluding You

But suppose now that you are a public benefactor and do not care to obtain a monopoly in your invention, although wishing at least to be able to use it yourself. If you have actually reduced it to practice and used it publicly, no subsequent inventor can get a valid patent covering it. But if you have never done this, if, let us say, the invention has never evolved beyond the experimental stage, although you may be convinced of its practical value, this abandoned experimental use will not act as a bar to a later inventor who may independently make the same invention, get a patent and stop you from practicing your own invention, at a later date. An invention which is never reduced to practice, or even if so reduced, never gets into public use, does not anticipate a later invention. It is important to bear this in mind.

How, then, can you prevent another from reinventing your abandoned or uncommercialized inventions, obtaining a patent which shall give him a monopoly and enable him to stop you from reviving and practicing what was once your own?

One solution, and perhaps the most simple one, is to publish the results of your experimental work in a printed publication. The mere reading of a paper at a convention is not enough. If your editor is agreeable (as to which I venture no opinion), I can think of no better medium of publicity than the *Journal* of this SOCIETY. The disclosure in this published article should be as complete as possible, setting forth all of the essential data, such as proportions, times, heat treatment, etc.—sufficient to enable one skilled in the art actually to practice the invention. A mere prophecy of probable results will not suffice. Such an article, if containing a clear and adequate disclosure, will make it impossible for a later inventor of the same thing to get a valid patent.

Another solution of the difficulty is to beat the other inventor to it and get a patent yourself. By doing this, you establish a date, at least as early as your filing date, and ordinarily you can carry back your date of invention much earlier. The later inventor must ante-date this to prevail.

Let us consider the effectiveness of these two solutions. If you publish your results, or actually put them in public use, it is true that no subsequent inventor can get a valid patent for the *same thing*. But this same thing, bear in mind, may be only the bare fundamental structure of your invention. Later improvements may, and probably will, be the features which give the invention real commercial value. Hence, a subsequent

inventor, stirred into activity by your publication, may make these valuable improvements upon your basic idea, and get patents which will actually dominate the field commercially and enable him to stop you, along with the general public which, in your altruism, you wish to benefit.

On the other hand, if you patent your invention, *you* are in a position to dominate the field, all later inventors having to pay tribute to you during the life of your patent, if you wish it. You may, of course, grant licenses free to those who wish to use your invention, and thus actually give the invention to the public quite as effectively as you might by a mere publication, more effectively, in fact, because you will be in a position to bargain with the later patentees for the protection of your public. It would still be true that these later patents could prevent your using the commercial improvements which they had made in your more fundamental invention, but as your patent would dominate, they, and their licensees, would be forced to do business with you if they would operate under their own patents.

It is, therefore, important to bear in mind that a dedication of an invention to the public can ordinarily be most effectively consummated through the actual obtaining of a patent. Public use and publication are useful but may simply stimulate activity and result in the issuance of improvement patents which may practically nullify the effect of your generosity.

To Sum Up

Do not stand in awe of the big word "invention." Have respect for your own improvements even though they may seem unimportant, and don't forget that patents are being granted on just such things.

If you wish to retain a monopoly in your inventions by practicing them in secret, very well, do so; but bear in mind that if another discovers your secret honestly your monopoly is gone.

If you decide to retain a monopoly through patents, proceed diligently to reduce your conceived inventions to practice and make applications for patent when this reduction is complete. Keep clear and authenticated records of all your work from conception to completion. File your applications within two years of first public use or sale of the inventions, and within two years of the date of the first description of them in a printed publication.

If you wish to make the public a gift of your inventions, publish a carefully prepared disclosure of them in some printed publication, or preferably, if you wish to protect yourself and the public from the patents of those who come later and improve upon your work, get patents yourself which will be broad enough to exact tribute from the improvement patentees, and thus enable you to trade with them for the protection of yourself and the public.

165 Broadway
New York City

ACTIVITIES OF THE SOCIETY

CHARTER MEMBERS HONORED AND NEWLY ELECTED OFFICERS INSTALLED AT BANQUET, FEBRUARY 12, 1923

The toast-master, Mr. L. E. Barringer, announced the results of the election as follows:

President, A. F. Greaves-Walker
Vice-President, R. D. Landrum
Treasurer, R. K. Hursh
Trustee, R. R. Danielson

Mr. Barringer then asked Professor Orton to take charge of the installation of these officers, and the following exercises took place:

INSTALLATION EXERCISES

CONDUCTED BY PROFESSOR EDWARD ORTON, JR., FOUNDER OF THE WORLD'S FIRST DEPARTMENT OF CERAMIC ENGINEERING AND OF THE AMERICAN CERAMIC SOCIETY

Mr. Toastmaster, before I attempt this difficult, and what may perhaps prove to be arduous, task, I should like to have some assurance as to how far my authority will go. Mr. Riddle, will you, as President of the SOCIETY until the next member thus honored is duly inducted into that high office,—Will you agree to back me up in any demand that I may make?

The Retiring President, Mr. Frank H. Riddle: Absolutely; go the limit! (Laughter.)

A good deal has been said about these charter members tonight, and most of them were placed on exhibit for a moment in the meeting this morning. But there are a few here who were not present at that time, and who perhaps do not know these men by sight; and I am going to take the liberty of asking them to rise in their places as I call their names, and remain standing for just a moment:

Mr. Charles Fergus Binns, Mr. Albert V. Bleininger, Mr. William D. Gates, Mr. Samuel Geijsbeek, Mr. Karl Langenbeck, Mr. Ellis Lovejoy, Mr. Herman C. Mueller, Mr. Francis W. Walker.

(Applause greeted each charter member as he rose upon his name being called.)

Face out, so they can all see you, boys! (Prolonged laughter and applause.)

Now a good deal has been said about the achievements of this little group,—all of a complimentary and flowery nature. My primary purpose in calling them to their feet in your presence here now, is not to laud them any more, but to serve as a sort of an object-lesson to you who are coming on. (Laughter.)

I do wish you to get this point of view. These men do not deserve any more adulation or praise or rewards of any sort for what they have done. They enjoy it; they lap it up, as Mr. Gates has indicated! (Laughter.) But the fact remains that they have been paid. They have been amply and well paid for the constructive work which they have done over this quarter of a century. They have drawn their pay as they went along. They had the fun of getting a big vision, and of seeing that vision come true. And I know that I speak for them truly when I say that you couldn't take the delight and the pleasure from them for the part that they have had in making this SOCIETY what it is, any more than the most cherished thing they possess. Am I right? (Applause.)

Well now, the application: These men are just common *homo sapiens*, the same as yourselves. They are not different. The chemists couldn't define their protoplasm as differing from yours. What they did, what they have enjoyed, is absolutely open

to the rest of us. Only one requirement: *Get the spirit that animated them!* And if this crowd,—five hundred of you, representing some nineteen hundred altogether, can animate yourselves with the same spirit and the same delight in doing things for the sake of doing them, that this group has had, the sky will hardly be the limit for the AMERICAN CERAMIC SOCIETY.

Now, there are two names on our list of charter members who can no longer be with us. Let us drink a silent toast to Ernest Mayer and to Jimmie Pass.

(Whereupon, the entire membership rose and drank, in silence, a toast to the departed members whose names had been mentioned.)

I should now like to have present themselves on the platform the following: Mr. Arthur F. Greaves-Walker, Mr. R. D. Landrum, Mr. R. C. Purdy, Mr. Ralph K. Hursh, Mr. R. R. Danielson.

(The gentlemen whose names were called, constituting the newly elected corps of officers of the SOCIETY, presented themselves on the platform.)

Now, ladies and gentlemen, this story that I am about to tell you is old to some of you; but this SOCIETY has grown very rapidly, and it may be new to some of you.

A certain member of this little charter group, Elmer E. Gorton, read a certain paper before the National Brick Manufacturers' Association twenty-five years ago, almost to a day. His paper was no very heavy composition; but it was the first attempt at that time to tell a non-technical audience an elementary fact about what constitutes a glaze, and how a glaze could be controlled. He told this story pretty well. He illustrated it on the black-board. He calculated his mixtures, and he got a respectful hearing from these brick men. It was evident that their attention was wandering from time to time, but they gave him a little perfunctory applause when he got through; and the chairman got up, and with a sort of sigh of relief said, "Well, we will take up next order of business!" Mr. Gorton came out of the hall, and I got up and followed him out, and Sam Geijsbeek, sitting here, followed me out also, and we walked down the hall with our arms around Gorton's shoulder. This happened, by the way, down at the old Monongahela House, at that time the best hotel in Pittsburgh.

As we walked out of that convention hall, Mr. Gorton said, "I don't feel very much pleased. I worked hard on this paper, but there does not seem to be any real interest here." We consoled him as we went along. About one hundred feet from the hall there was an old plush-covered settee—the same settee is there now, I think, that was there then! (Laughter.) I judge so, because the plush came off when I sat down on it twenty-five years ago, and it came off again today! (Laughter.) Three of us went down to our shrine today, and we sat on that old settee and speculated a little about things. On that former occasion Gorton was bemoaning the fact that he hadn't quite rung the bell with that paper. One of us said, "Well, there's only one way to cure that. If you want to have topics of this sort discussed by people that enjoy such matters, you will have to get the kind of people that enjoy them together. Why not try the thing out a little bit, and see if we couldn't organize just a small group that would care for such a paper?" Well, you know, once in a long time in men's careers, a suggestion like that will strike fire in the brains of others. I can't for the life of me say now whether it was Gorton or Geijsbeek or myself that made that suggestion. But anyhow all three of us were presently aflame with the new idea, and we talked it over for a few minutes, getting more and more interested, and we said, "Now, who is there here that could be relied on in this convention that would care for this thing?" And we speculated, and we picked on Gates, Lovejoy, W. D. Richardson, Bleininger, and two or three others,—eleven in number, and we gathered around the table that same night in a room now used as a drug-store and there we laid the plans for the AMERICAN CERAMIC SOCIETY.

As I say, we made our pilgrimage down to that shrine to-day. The shrine isn't much, but the inspiration which rose in us from the work we did there has been the keystone, I would say, in the lives of most of us.

I am telling you this little story, as I said in the beginning, that all of you newcomers into the SOCIETY, as well as the old members, may hear and know of the accidental—the almost accidental genesis of the organization.

Mr. Purdy, our efficient Secretary, has recently, in the monograph which he has gotten out in honor of this occasion, told the greater portion of this anecdote, but I wanted you to know it at first hand from those who actually participated in it.

Now, gentlemen, the characteristic of those first eleven men, and later the first twenty-two men, was the fact that they were idealists. The word "service," which is used so very frequently now in uplift organizations of all sorts, was not then in use. We didn't hear the word "service" in its common and frequent significance of today. We had no clubs or technical organizations which were stressing "service" at that time. But that little group of men saw a situation; they saw an old industry, a big industry, a fundamental industry. And they saw an industry standing low in the popular opinion; they saw an industry with very little progressiveness; they saw an industry with very little knowledge of its own problems. These men were acting individually. Most of them did not know each other well, some of them hardly at all. They did believe in the power of friendly coöperation. And as they associated themselves together, they soon believed in each other. Among them action begat action; faith begat faith. Action and faith move mountains. They believed, if the barriers of custom and suspicion should be broken down, and the real human being beneath could be approached, that the good in all these men in the clay industries would concur, and that there would be a greater future, as well as a happier present, for the clay industry, if this organization could unlock these old barriers. This little group of twenty-two men,—nine of us here to-night—did not and could not foresee what has happened; but they sensed very well that whatever happened would be in the direction of what has happened here.

(Professor Orton then turned to the newly elected officers.)

Now, you have been selected in the legal and constitutional manner, to take over the fortunes and guide the destinies of this great organization. In one sense your task is easier than that of your forebears, because your field is now defined and crystallized in the popular mind. In another sense, it's much more human, because the energies of these nineteen hundred men and women are so vast and so potential for good or for bad, that it's now a matter of national concern that this SOCIETY shall be well led. It did not matter much what the original twenty-two said or thought; they had no national status; but what this group says is a matter of national concern.

Now may I presume to say to you that there's just one key that will unlock the doors to all the difficulties that will arise in your behalf, and that key is the one which was forged by this little group,—the key of idealistic service, the unselfish desire to marshal your own forces and those for which you stand the chosen leaders for the betterment of your industry, for the betterment of this country, for the betterment of the human race. I believe that this cause is a holy cause. Our beloved SOCIETY has the same spirit exactly that animated the old Crusaders, as they sought for the Holy Grail. I will now read to you this induction pledge:

"The thing which marks one group of men as better than another is not their wealth, their culture, their skill. It is their spirit of coöperation, the ability and willingness to pool their energies unselfishly in the cause of human advancement. Recognizing the truth of this principle, do you now, in assuming the leadership of this splendid group of American scientists, accept your respective offices as a sacred trust, and

consecrate yourselves anew through service to this organization, to the broader service of mankind?"

The Officers-elect: I do.

Professor Orton: In virtue of the authority temporarily vested in me, I pronounce these men duly qualified and elected officers of this Association, and I extend the right hand of fellowship.

Mr. Greaves-Walker, President of the SOCIETY. (Applause.) Mr. R. D. Landrum, Vice-President of the SOCIETY. (Applause.) Mr. Purdy, the Secretary of the SOCIETY. (Applause.) Mr. Hursh, your Treasurer. (Applause.) Mr. Danielson, your newly elected member of the Board of Trustees. (Applause.)

Secretary Purdy: I should like to ask Mr. Salisbury and Mr. Howe to stand up with those here, that all may see those who are guiding the destinies of this association.

The Toastmaster, Mr. Barringer: Professor Orton, you have just stated, in sketching the origin of the SOCIETY, that one of your former pupils, Mr. Gorton, presented for the first time before the National Brick Makers' Association a technical paper, describing a series of experiments, using chemical formulae as the basis. Your students know that Gorton could not have presented that paper if it had not been for yourself. In your address this morning, you stated that character-building was the foundation of education. From the first class that entered your instruction in 1894, throughout the period of your teaching, I am sure that every one of your pupils has realized that you have been preëminently a teacher who has builded character.

I have here a book containing the letters of some fifty of your former pupils attempting to state their appreciation of what you have done for them, not by advice and instruction in the class-room only, but by the inspiring example of your character, of your being yourself, all that is worth while in life. There is one chap here who says that he saw the best side of Professor Orton, because he was a fellow in need. That student is not alone. I know a half dozen of them. I myself, as one of Professor Orton's pupils, was a "fellow in need," and I know that there's where his friendship and sympathy and encouragement shine to the best effect.

We have also gathered here the papers with reference to the placing of a portrait of Professor Orton in the Ceramic Building at Rutgers College.

What a different world this would be, gentlemen and ladies, if each one of us could influence the lives, and definitely know it, of at least fifty people. Professor Orton, I know you have touched the lives of hundreds. But here, as an appreciation of this group of fifty, we wish to present you with a collection of letters expressing, as best they can, their love for you and their heartfelt gratitude for what you have been to them. (Prolonged applause.)

Professor Orton: Mr. Chairman, you certainly couldn't expect any response to this. Something of this sort deprives one of the ordinary modes of communication. All I can say is that this book will remain my very dearest possession. (Applause.)

THE SILVER JUBILEE CONVENTION EXHIBIT OF CERAMIC PRODUCTS

The exhibit this year was larger, better, and covered a wider range than did the exhibit of 1922. The interest shown in this exhibit by the attending delegates and by local ceramists has established it as a feature of the annual conventions. A special committee will hereafter take the responsibility of organizing and caring for the exhibit.

Although the Art Division has, for the past two years, been through the difficulties of getting organized and of building up a program of service, it conceived and success-

fully carried into execution the exhibit of ceramic products. Rather than being a load, or to any degree adding to the responsibilities which the officers of this Division were assuming, they found that the exhibit assisted in attracting new membership support to their Division work and program. To Mr. Frederick H. Rhead belongs the credit of having established this instructive feature of our annual convention. He has given to it a large amount of time and, of greater value, the required executive and artistic ability so essential to the success of so ambitious an enterprise. To Mr. James C. Boudreau and Mr. H. S. Kirk, able collaborators with Mr. Rhead, is due a large share of the credit and praise for the success of the 1923 exhibit.

The following individuals and firms were the exhibitors:—

ART DIVISION

Arthur E. Baggs, Marblehead, Mass.
Newcomb Pottery, New Orleans, La.
Paul Revere Pottery, Boston, Mass.
Overbeck Pottery, Cambridge City, Ind.
Fulper Pottery, Flemington, N. J.
Russel Crooks, Boston, Mass.
Wahl Co., Chicago, Ill.
Munsell Color Company, New York City.
Frederick H. Rhead, Zanesville, Ohio
Mrs. Frederick H. Rhead, Zanesville, Ohio
Mrs. Bertha Riblet Pire, Wesleyville, Pa.
Miss May Elizabeth Cook, Columbus, Ohio
Rookwood Pottery Co., Cincinnati, Ohio

EDUCATIONAL EXHIBITS

The Carnegie Library, Pittsburgh, Pa.
Schenley High School, Pittsburgh, Pa.

ENAMEL DIVISION

Stanley Insulating Co., Great Barrington, Mass.
O'Hara Waltham Dial Company, Waltham, Mass.
The Elyria Enameled Products Co., Elyria, Ohio
The Vitro Manufacturing Co., Pittsburgh, Pa.
Vitreous Steel Products Co., Nappanee, Ind.

GLASS DIVISION

Corning Glass Works, Corning, N. Y.
Bausch & Lomb Optical Co., Rochester, N. Y.

HEAVY CLAY PRODUCTS DIVISION

Hydraulic Press Brick Co., Roseville, Ohio

REFRACTORIES DIVISION

Lavino Refractories Co., Philadelphia, Pa.
American Refractories Co., Joliet, Ill.
Mitchell Clay Manufacturing Co., St. Louis, Mo.
The Carborundum Co., Keasbey, N. J.
Charles Engelhard, Inc., New York City
Crescent Refractories Co., Curwensville, Pa.
Precision Grinding Wheel Company, Philadelphia, Pa.
Norton Company, Worcester, Mass.

TERRA COTTA DIVISION

Conkling-Armstrong Terra Cotta Co., Philadelphia, Pa.
Midland Terra Cotta Co., Chicago, Ill.
New York Architectural Terra Cotta Co., Long Island City, N. Y.

WHITE WARES DIVISION

Edwin M. Knowles China Co., Newell, W. Va.
The Mayer China Co., Beaver Falls, Pa.
Universal Sanitary Manufacturing Co., New Castle, Pa.
Hardinge & Co., Inc., New York City
Coors Porcelain Co., Golden, Colo.
The Homer Laughlin China Co., Newell, W. Va.
National Lime Association, Washington, D. C.
O'Brien & Fowler, Buckingham, Quebec, Can.
Saskatchewan Government and University, Saskatoon, Canada
Beaver Falls Art Tile Co., Beaver Falls, Pa.
The Roessler & Hasslacher Chemical Co., New York City.

THE WHITE WARES DIVISION

At the annual meeting of the White Wares Division, held in Pittsburgh, February 13 and 14, the following officers were chosen for the coming year:

Chairman.....F. H. Riddle
Secretary.....C. C. Treischel

Chairmen of Committees and Representatives on Coördinating Service Council

Research.....F. K. Pence
Standards.....H. Spurrier on Specifications
George Sladek on Tests
Membership.....Ira E. Sproat
Rules.....August Staudt
Ceramic Education.....Geo. H. Brown
Data.....C. C. Treischel
Nominating.....C. E. Jackson

In the work for the coming year the Division will concentrate on (1) A Classification for Feldspars, (2) Specifications and Classification for Flint and Whiting, (3) Coöperative Research on Saggers, (4) Researches on Domestic Ball Clays, (5) Researches on Kiln Firing, (6) The Ceramic Handbook.

Items (1) and (2) will be taken up by the Standards Committee which is to consist of ten members, six representing the consumers and four the producers. This Committee expects to hold three meetings during the year and hopes to develop a Classification that can be used as a basis for drawing up Specifications.

Item (3) will be handled by the Research Committee and their efforts will be directed toward a united effort on the part of the Bureau of Standards and the various Trade Associations of this Division.

Items (4) and (5) will be the basis for papers for the next annual meeting.

C. C. TREISCHEL, *Secretary*

PROPOSED AMENDMENTS TO THE CONSTITUTION

Article II, Section 5, to read

"Active Members must be persons competent to fill responsible positions in Ceramics. Only Associate Members shall be eligible to election as Active Members and such election shall occur automatically twenty-four months after acceptance as an Associate Member."

Article IV, Section 1, to read

"The affairs of the SOCIETY shall be managed by a Board of Trustees, consisting of the President, Vice-President, Treasurer, the two most recent past Presidents, and one trustee representative of each of the Divisions. The President, Vice-President and Treasurer shall be elected to serve one year. Each Trustee shall be elected to serve three years."

Article V, to read

NOMINATIONS AND ELECTIONS

(1) Nominating Committee. The Nominating Committee shall be composed of the two most recent past Presidents and one representative selected by each Division and by each Local Section. The Secretary of the SOCIETY shall be Chairman (without vote).

(2) Any ten Active Members may constitute a self-appointed Nominating Committee and present names of nominees for President, Vice-President, and Treasurer to the Secretary for placement on the election ballot, provided such names are presented at least thirty days before the annual meeting.

(3) Nominations for President, Vice-President, and Treasurer. The Nominating Committee shall, by majority letter vote, select nominees for President, Vice-President, and Treasurer.

(4) Nominations for Trustees. Each Division by plurality letter vote of the major members of the Division shall select a nominee for Trustee to serve for a period of three years, according to the schedule provided in Section X of the By-Laws.

The names of the nominees for Trustees thus chosen by the Divisions shall be transmitted to the Secretary of the SOCIETY (as ex officio Chairman of the Nominating Committee) not later than September first, and by him shall at once be transmitted to the members of the Nominating Committee, and shall be placed on the election ballot.

At least ninety days before the annual meeting the Secretary shall send the names of all nominees to each voting member of the SOCIETY.

(5) Election. The names of all nominees, provided their assent has been obtained before nomination, shall be placed upon a printed ballot in alphabetical order and shall be mailed to each voting member not in arrears at least twenty days before the annual meeting. The voting shall be confined to the names appearing on this ballot. The ballot shall be enclosed in an envelope on which there shall be no mark of identification other than the word "Ballot." The envelope shall be enclosed in another envelope for mailing, addressed to the Secretary, upon the back of which the voter shall endorse his name.

The envelopes and ballots shall be opened in the presence of three scrutineers appointed by the President, who will report the result of the election at the annual meeting.

A plurality of affirmative votes cast shall elect.

Article VII. Add following clause to the last sentence of Paragraph 1.

"—but for purpose of nominating for Division representative on the Board of Trustees each member must declare one and only one Division as his major Division, and he shall be designated as a major member of that Division."

Article XII. For the words "a regular meeting" substitute the words "the annual meeting" as provided in Section 1 of the By-Laws.

By-Laws. Section X.

To provide for rotation of the nominations of Trustees as representatives of the Divisions, as provided in Articles IV and V of the Constitution, some shall be nominated in 1923 to serve portions of the three-year terms as follows:

Terra Cotta to serve three years.
Enamels to serve one year.
Refractories to serve one year.

White Wares to serve two years.
Art to serve one year.
Heavy Clay Products to serve three years.
Glass to serve two years.

By-Laws. Section XI. Same as present Section X

BETWEEN SEASONS

The ski-jumping season was short and the record of membership work for March is shorter. Winter sports are over, spring sports are not yet in vogue, except the sports in the south and they aren't hunting for members. The list is fully as long as many a list of last year, but after the towering total reported last month it is a bit of a come-down. Our college professors rallied at the time of need, as they do so often, and A. S. Watts sent in two names, R. K. Hursh, two, C. W. Parmelee, two, J. B. Shaw, one, and D. A. Moulton, one. Karl Türk and L. R. Allison also sent in two each. The rest of the scoring was scattered, geographically and numerically. Illinois leads with seven, closely rivaled by Ohio with six. Maryland, New Jersey, and Pennsylvania each sent two representatives. Massachusetts, New Hampshire, Maine, Iowa, Indiana, New York, and Washington say "present" once each, as does Canada, while remarkably enough two members from Holland clattered over just in time to get listed.

The roll of workers follows:

	Personal		Personal
Gordon B. Wilkes	1	Charles A. Smith	1
D. A. Moulton	1	R. K. Hursh	2
A. S. Watts	2	Chas. E. Kraus	1
Joseph Keele	1	L. E. Barringer	1
B. T. Sweely	1	J. B. Shaw	1
L. R. Allison	2	C. W. Parmelee	2
W. A. Hull	1	G. Z. Minton	1
Karl Türk	2	H. S. Kirk	1
R. W. Hemphill	1	Office	7

Total 29

STATUS OF MEMBERSHIP

	Personal	Corporation
Status Jan. 12	1611	216
Dropped for non-payment of dues	21	1
	1590	215
Resigned	19	2
	1571	213
New Members received since Jan. 12	139	10
Status March 14	1710	223

The net increase therefore has been 99 personal and 7 corporation members. Resignations will be fewer for the remainder of the year and there will be no more dropped for non-payment of dues, since this act of swift justice occurs but once a year. There remain, therefore, 301 personal and 93 corporation memberships to be obtained in order to fulfil the hopes and plans of the budget. There are forty-one weeks left in 1923. There has been an average of five memberships a week received in the office of the Secretary, without any special effort by anyone so far as is known. Is there any reason why we cannot reach the necessary average of 7.31 personal members and 2.26 corporations every week. This means of course that many more must be received some weeks in order to cover the lean summer months when nobody joins anything except the lip and the cup of ice-water. Let's begin right away!

NEW MEMBERS RECEIVED FROM FEB. 11 TO MARCH 14, 1923

Bates, Oscar Kenneth, Room 4–145, Mass. Institute of Technology, Cambridge, Mass., Instructor of Physics.

Bruechert, Horace, 2826 West St., Ames, Iowa, Student, Iowa State College.

Campbell, John, Asbestos Wood Co., Nashua, N. H., Chemical Engineer.

Clawson, C. D., 1942 Iuka Ave., Columbus, Ohio, Student, Ohio State University.

Fréchette, Howells, Mines Branch, Dept. of Mines, Ottawa, Canada, Chief of Division of Ceramics and Road Materials.

Fusselbaugh, Reardon, 2028 Mt. Royal Ave., Baltimore, Md., Assistant Superintendent, Baltimore Enamel & Novelty Co.

Gallagher, Hugh S., Box 165, East Liverpool, Ohio, Vice-President, National Products Co.

Galvin, Gerald M., 2223 S. 18th St., Philadelphia, Pa., U. S. Navy Yard.

Gould, James, 1510 Electric St., Scranton, Pa., Superintendent, Scranton Enameling Co.

Hersey, Geo. F., Colonial Insulator Co., Akron, Ohio, Superintendent, Colonial Insulator Co.

Hobson, Stanley H., Geo. D. Roper Corp., Rockford, Ill., Director of Engineering.

Koenig, Franz J. M., Ivan Beirenstraat 12, Schoonhoven, Holland, Industrial Manager, Schoonhoven Pottery.

Legnard, W. M., 20 E. Jackson Blvd., Chicago, Ill., Vice-President, Interstate Clay Products Co.

Lucktenberg, Wm. H., Zanesville, Ohio, Vice-President, The Burton-Townsend Company.

Milliken, Edward C., 1892 N. High St., Columbus, Ohio, Student, Ohio State University.

Mundy, O. S., 905 W. Green St., Urbana, Ill., Student, University of Illinois.

Neiswanger, Samuel O., 107 S. 3rd St., Champaign, Ill., Student, University of Illinois.

Patch, Clifford, Bangor, Maine, Chemical Engineer, Orono Pulp & Paper Co.

Schoonenberg, Pancras, Library Dept., Philips' Glowlampworks, Eindhoven, Holland, Managing Engineer.

Scott, A. Lincoln, Auditorium Tower, Chicago, Ill., Research Engineer, American Hotels Association.

Tsou, We Wei, 76 W. Frambes Ave., Columbus, Ohio, Student, Ohio State University.

Vachuska, Edward J., Alfred, N. Y., Student, New York State School of Ceramics.

Watts, Orlando S., 629 Walnut St., Camden, N. J., President, Standard Enameling & Mfg. Co.

Weiskittel, Harry C., Jr., 4500 E. Lombard St., Baltimore, Md., Assistant Manager, A. Weiskittel & Son Co.

Whitehead, Fred, Foskett St., Trenton, N. J., Proprietor, Whitehead Pottery Co.
Williams, Glenn D., 836 N. County St., Waukegan, Ill., Ceramic Engineer, Chicago Hardware Foundry Co.
Wilson, J. A., 1001 South B St., Elwood Ind., Pittsburgh Plate Glass Co.
Worman, Eugenie A., 4809 Beach Drive, Seattle, Wash., Teacher of Pottery, University of Washington.
Wright, Edward P., Irwin, Ill., Student, University of Illinois.

WHO'S WHERE IN THE AMERICAN CERAMIC SOCIETY

Richard M. Balmert, formerly superintendent of the Lyth Tile Co. at Angola, N. Y., is now living at 1605 W. Lombard St., Baltimore, Md.

R. R. Danielson has recently affiliated himself with the Beaver Enameling Co. at Ellwood City, Pa. He is still connected with the Bureau of Standards and is in Washington part of the time.

M. C. Booze has been made Senior Fellow in Refractories at the Mellon Institute, Pittsburgh, taking the place of **R. M. Howe** who is now with the Kier Fire Brick Co.

E. A. Brockman and **A. C. Stepan,** of the Roessler and Hasslacher Chemical Co., may be found at the new offices of the company, 230 E. Ohio St., Chicago.

Sven Fogelberg, who was Assistant Director of the Kosta Glass Works, is now at the Hammars Glaswerk, Askersund, Sweden.

G. F. Bissell, of the Chicago Retort and Fire Brick Co., at Ottawa Ill., is now at the Chicago office of the firm.

Benjamin Alderson, who is connected with the American Bottle Co., has been transferred from Streator, Ill., to Newark, Ohio.

Victor W. Boeker, a student in the Ceramic Department of the University of Illinois, is now living at 1210 W. Illinois St., Urbana.

Charles J. Corty, superintendent of the American Foundry and Range Co., has moved from Arthur St. to 507 East A St., Belleville, Ill.

H. D. Callahan, with the National Fire Proofing Co., gives as his new address, 87 Maple Place, Keyport, N. J.

George Brain, for many years manager of the Universal Sanitary Mfg. Co., has recently taken a position with the Standard Sanitary Mfg. Co. at Tiffin, Ohio.

G. L. Rogers, of the Denny Renton Clay and Coal Co., has been transferred from Renton, Washington, to the Seattle office of the firm.

C. A. Underwood has been placed in the New York office of the American Refractories Co. at 120 Broadway, instead of at the Joliet, Illinois, plant.

G. W. Greenwood has changed his address from Wilkes-Barre to Dunbar, Pa.

NOTES AND NEWS

WHAT THE AMERICAN SOCIETY FOR TESTING MATERIALS HAS DONE IN CERAMICS

PAPERS DEALING WITH CLAY PRODUCTS

"A Machine for Testing Clay Products," by Mont Schuyler, Vol. XIV, Part II, p. 557 (1914).

"The Legal Interpretation of the Word 'Vitrified' as Applied to Ceramic Products," by Edward Orton, Jr., Vol. XV, Part II, p. 245 (1915).

"Comparison of Heat-Insulating Properties of Materials Used in Fire-Resistive Construction," by W. A. Hull, Vol. XVII, Part II, p. 422 (1917).
"Failure of a 30-in. Tile Drain at Albert Lea, Minnesota," by R. W. Crum, Vol. XVII, Part II, page 453 (1917).
"The Necessity for Inspection and Testing of Refractory Brick," by C. E. Nesbitt and M. L. Bell, Vol. XVIII, Part II, p. 336 (1918).
"Preventable Defects in Refractory Bricks," by C. E. Nesbitt and M. L. Bell, Vol. XIX, Part II, p. 619 (1919).
"Testing of Porosity of Electrical Porcelain," by W. D. A. Peaslee, Vol. XX, Part II, p. 495 (1920).
"Vital Factors in the Testing of Fire-Clay Refractories and in the Interpretation of Results," by R. M. Howe, Vol. XX, Part I, p. 278 (1920).
"A Study of the Proposed A.S.T.M. Tentative Specifications for Building Brick and a Correlation of Their Requirements with Sodium-Sulfate Treatment and Actual Freezing," by Edward Orton, Jr., Vol. XIX, Part I, p. 268 (1919).
"Practical Methods for Testing Refractory Fire Brick," by C. E. Nesbitt and M. L. Bell, Vol. XVI, Part II, p. 349 (1916).
"Testing of Refractories," by A. V. Bleininger, Vol. XIII, p. 967 (1913).
"Slag Test for Refractory Brick Used in the Iron and Steel Industry," by C. E. Nesbitt and M. L. Bell, Vol. XVII, Part I, p. 314 (1917).
"A Study of the Rattler Test for Paving Brick," by M. W. Blair and Edward Orton, Jr., Vol. XI, p. 776 (1911).
"Notes on Brick Pier Tests," by James E. Howard, Vol. VII, p. 475 (1907).
"Some Further Experiments upon the Absorption, Porosity and Specific Gravity of Building Brick," by D. E. Douty and L. L. Beebe, Vol. XI, p. 767 (1911).
"The Influence of the Absorptive Capacity of Brick upon the Adhesion of Mortar," by D. E. Douty and H. C. Gibson, Vol. VIII, p. 518 (1908).
"The Rattler Test for Paving Brick as a Safe Method of Disclosing the Limit of Permissible Absorption," by Edward Orton, Jr., Vol. V, p. 287 (1905).
"Standard Tests for Drain Tile and Sewer Pipe," by Anson Marston, Vol. XI, p. 833 (1911)

LIST OF A.S.T.M. STANDARDS AND TENTATIVE STANDARDS DEALING WITH CERAMICS

A.S.T.M. Standard Specifications for:

Paving Brick (C7–15)
Building Brick (C21–20)
Clay Sewer Pipe (C13–20)
Drain Tile (C4–21)

A.S.T.M. Standard Methods of:

Test for Refractory Materials under Load at High Temperatures (C16–20)
Test for Porosity and Permanent Volume Changes in Refractory Materials (C20–20)
Test for Softening Point of Fire-Clay Brick (C24–20)
Ultimate Chemical Analysis of Refractory Materials, including Chrome Ores and Chrome Brick (C18–21)

A.S.T.M. Standard Recommended Practice for:

Laying Sewer Pipe (C12–19)

A.S.T.M. Standard Definitions of:

Terms Relating to Sewer Pipe (C8–15)
Terms Relating to Clay Refractories (C27–20)

A.S.T.M. Tentative Specifications for:

Clay Sewer Brick (C23–21 T)
Required Safe Crushing Strengths of Sewer Pipe to Carry Loads from Ditch Filling (C15–17 R)
Clay Hollow Building Tile (C34–21 T)

A.S.T.M. Tentative Methods of:

Test for Slagging Action of Refractory Materials (C17–19 T)
Test for Resistance of Fire-Clay Brick to Spalling Action (C38–21 T)

A.S.T.M. Tentative Definitions of:

Terms Relating to Hollow Tile (C43–21 T)

GLASSWARE AND POTTERY EXHIBITS TO BE FEATURED IN NATIONAL EXPOSITION AT ATLANTIC CITY THIS SUMMER

The American Home and City Beautiful Association has recently issued an announcement outlining plans for a great Industrial American Exposition, to rival the greatest of those of the European countries, which will take place on the Million Dollar Pier, Atlantic City, N. J., from June 16 to September 8, 1923. The Exposition is arranged with a two-fold object of encouraging the use of articles of American manufacture and the education of the people of the United States in home and city beautification.

All of the exhibit floor space of the Million Dollar Pier—America's most attractive exhibition structure (in excess of 100,000 sq. ft.)—has been engaged for this exhibit, which will be devoted to eight principal groups with more than thirty allied classifications as follows:—Public and Private Buildings, materials, equipment, and furnishings; The Garden, seeds, accessories, and supplies; Art, Sculpture and Ornaments; Musical Instruments and Reproducers; The City Beautiful embracing Municipal Improvements, Hygiene, Sanitation, Accident and Fire Prevention; Pure Food Products, Confections and Beverages; Recreation, Athletics; Resort and Travel information, to boost "Seeing America First;" and an important section devoted to Radio.

Realizing the importance of the Glass and Pottery industry, as producers of essentials of practical utility and beauty in the home, the Exposition Management has set aside some of the most attractive sections of the Exposition to display and demonstrate the various kinds of Pottery, Glassware, China and Art novelties, and a varied assortment of household utilities.

Various trade organizations interested in the several branches of these industries as well as individual manufacturers and distributors will be prominently represented at the Exposition.

An Exposition folder giving full particulars regarding the exhibition will be mailed free to those who apply to the American Home and City Beautiful Exposition, Million Dollar Pier, Atlantic City, N. J.

LIST OF PUBLICATIONS OF CERAMIC INVESTIGATIONS, U. S. BUREAU OF MINES

PUBLISHED IN OUTSIDE JOURNALS

"The Effect of Some Electrolytes on the Properties of Clays" (H. G. Schurecht). *Jour. Am. Ceram. Soc.*, Vol. 1, No. 3, 1918.

"A Pycnometer Operated as a Volumeter" (H. G. Schurecht). *Jour. Am. Ceram. Soc.*, Vol. 1, No. 8, 1918.

"The Properties of Some Ohio and Pennsylvania Stoneware Clays" (H. G. Schurecht). *Jour. Am. Ceram. Soc.*, Vol. 1, No. 4, 1918.

"Fusibility of Graphite Ash and its Influence on the Refractoriness of Bond Clay" (M. C. Booze). *Jour. Am. Ceram. Soc.*, Vol. 2, No. 1, Jan., 1919.

"Behavior under Brass Foundry Practice of Crucibles Containing Ceylon, Canadian, and Alabama Graphites" (R. T. Stull). *Jour. Am. Ceram. Soc.*, Vol. 2, No. 3, March, 1919.

"Experiments in Dead-Burning Dolomite" (H. G. Schurecht). *Jour. Am. Ceram. Soc.*, Vol. 2, No. 4, April, 1919.

"Effect of Variable Pressure and Tar Content on the Briquetting of Alabama Graphite" (Stull and Schurecht). *Jour. Am. Ceram. Soc.*, Vol. 2, No. 5, 1919.

"Some Properties of Bond Clays for Graphite Crucibles" (M. C. Booze). *Jour. Am. Ceram. Soc.*, Vol. 2, No. 6, 1919.

"The Effect of Electrolytes on the Properties of Graphite Crucible Bodies" (H. G. Schurecht). *Jour. Am. Ceram. Soc.*, Vol. 2, No. 6, 1919.

"A Machine for Testing the Hot Crushing Strength of Firebricks" (H. G. Schurecht). *Jour. Am. Ceram. Soc.*, Vol. 2, No. 8, Aug., 1919.

"The Position of Clay Products in the Field of Earthen Products" (R. T. Stull). *Brick and Clay Record*, March 6, 1919.

"Graphites and Bond Clays for Crucible Making Purposes" (R. T. Stull). *Proc. 22nd Am. Mining Congress*, p. 766, Nov. 17–21, 1919.

"The Need of Technical Assistance in the Brick Industry" (R. T. Stull). *Jour. Am. Ceram. Soc.*, Vol. 3, No. 3, March, 1920.

"Government Service in Developing the Clay Industry" (R. T. Stull). *Clay Worker*, March 25, 1920.

"Elutriation Tests on American Kaolins" (H. G. Schurecht). *Jour. Am. Ceram. Soc.*, Vol. 3, No. 5, May, 1920.

"Behavior of Fire Brick in Malleable-Furnace Bungs" (H. G. Schurecht). *Jour. Am. Ceram. Soc.*, Vol. 3, No. 7, July, 1920.

"The Fusibility of Mixtures of Graphite Ash and Bond Clays" (R. N. Long). *Jour. Am. Ceram. Soc.*, Vol. 3, No. 8, Aug., 1920.

"A Direct Reading Overflow Volumeter" (H. G. Schurecht). *Jour. Am. Ceram. Soc.*, Vol. 3, No. 9, Sept., 1920.

"Some Properties of Refractories" (R. T. Stull). *Proc. Electric Furnace Assoc.*, meeting at Columbus, O., Oct. 6, 1920.

"The Effect of Wet Grinding, Screening, and Electrolytes and Dextrine on Clays of Low Plasticity" (H. W. Douda). *Jour. Am. Ceram. Soc.*, Vol. 3, No. 11, Nov., 1920.

"Experiments in Aventurine Glazes" (H. G. Schurecht). *Jour. Am. Ceram. Soc.*, Vol. 3, No. 12, Dec., 1920.

"Experiments in Dead-Burning Dolomite and Magnesite" (H. G. Schurecht). *Jour. Am. Ceram. Soc.*, Vol. 4, No. 2, Feb., 1921.

"Some Properties of Bodies and Glazes Used in the Pottery Industry, together with notes on Lusters and Aventurine Glazes" (H. G. Schurecht). *New Jersey Ceramist*, Vol. 1, No. 1, March, 1921.

"Notes on the Effects of Firing Temperatures on the Strength of Fireclay and Stoneware Bodies" (H. G. Schurecht). *Jour. Am. Ceram. Soc.*, Vol. 4, No. 5, May, 1921.

"The Separation of Lime from Dolomite" (H. G. Schurecht). *Jour. Am. Ceram. Soc.*, Vol. 4, No. 7, July, 1921.

"Sedimentation as a Means of Classifying Extremely Fine Clay Particles" (H. G. Schurecht). *Jour. Am. Ceram. Soc.*, Vol. 4, No. 10, Oct., 1921.

"The Degree to which Different Glaze Compositions Take Vapor Lusters" (R. T. Watkins). *Jour. Am. Ceram. Soc.*, Vol. 5, No. 1, Jan., 1922.

"The Microscopic Examination of the Mineral Constituents of Some American Kaolins" (H. G. Schurecht). *Bull. Am. Ceram. Soc.*, Vol. 5, No. 1, Jan., 1922.

"Mechanism of Plasticity from Colloid Standpoint" (G. A. Bole). *Jour. Am. Ceram. Soc.*, Vol. 5, No. 8, August, 1922.

"An Account of an Investigation of Some Georgia Clays and Bauxites" (Gilmore and Fessler). *Jour. Am. Ceram. Soc.*, Vol. 1, No. 5, Sept., 1922.

"A Simple Control Porosimeter" (G. A. Bole—F. G. Jackson). *Brick and Clay Record*, Vol. 61, No. 5, Sept. 5, 1922.

"The Mechanical Movement of Water through Clays and its Control" (H. G. Schurecht). *Jour. Am. Ceram. Soc.*, Vol. 5, No. 12, Dec., 1922.

"Purification and Analysis of ZrO_2" (Jackson-Shaw). *Jour. Am. Chemical Soc.*, Dec., 1922.

"Note on Direct Reading Automatic Laboratory Scale for Weighing Briquettes" (H. G. Schurecht). *Jour. Am. Ceram. Soc.*, Vol. 6, No. 3, March, 1923.

"Tests on Some Refractory Clays of California" (H. W. Douda). *Jour. Am. Ceram. Soc.*

"Dolomite Cements Involving the Sorel Reaction" (Stull and Schurecht). *Jour. Am. Ceram. Soc.*

"The Properties of Some Clay-Like Minerals of the Bentonite Type" (Schurecht and Douda). *Jour. Am. Ceram. Soc.*

"Coal Formation Clays of Ohio" (Stout, Stull, Demorest, McCaughey). *Ohio Geol. Survey Bulletin.*

"Permeability of Refractories to Air" (H. W. Douda). *Jour. Am. Ceram. Soc.*

"Preliminary Report on the Residual Kaolin and Feldspar in the Pacific Northwest" (H. Wilson, A. L. Bennett, and F. T. Heath). *Jour. Am. Ceram. Soc.*, Vol. 6, No. 3, March, 1923.

"Clays and Shales in the State of Washington, their Technology and Uses" (Hewitt Wilson). *State Bulletin*, Wash., 1922.

The above publications are usually available in large technical libraries, or can possibly be purchased by writing the publishers or book-dealers who specialize in the sale of back numbers of trade and technical journals.

Issued as a Publication of the Bureau of Mines

Bulletins

*Bulletin 53. "Mining and Treatment of Feldspar and Kaolin in the Southern Appalachian Region," by A. S. Watts. 1913. Out of print.

**Bulletin 71. "Fuller's Earth," by C. L. Parsons. 1913. 5 cents.

**Bulletin 92. "Feldspars of the New England and Northern Appalachian States," by A. S. Watts. 1916. 25 cents.

Bulletin 112. "Mining and Preparing Domestic Graphite for Crucible Use," by G. D. Dub and F. G. Moses. 1920.

Bulletin 128. "Refining and Utilization of Georgia Kaolins," by I. E. Sproat. 1916.

**Bulletin 160. "Rock Quarrying for Cement Manufacture," by Oliver Bowles. 1918. 25 cents.

TECHNICAL PAPERS

*Technical Paper 99. "Probable Effect of the War in Europe on the Ceramic Industries of the United States," by A. S. Watts. 1915. Out of print.

Technical Paper 126. "The Casting of Clay Wares," by T. G. McDougal. 1916.

**Technical Paper 155. "Gypsum Products, Their Manufacture and Uses," by R. W. Stone. 1917. 20 cents.

Technical Paper 203. "Labor Saving at Limestone Quarries," by Oliver Bowles. 1919.

Technical Paper 212. "The Determination of Combustible Matter in Silicate and Carbonate Rocks," by A. C. Fieldner, W. A. Selvig, and G. B. Taylor. 1919.

**Technical Paper 233. "The Properties of Some Stoneware Clays," by H. G. Schurecht. 1920. 10 cents.

Technical Paper 281. "The Use of Electrolytes in Purifying Clays," by H. G. Schurecht. 1922.

* Can be consulted at most public libraries.

** Obtainable only through the Superintendent of Documents, Government Printing Office, Washington, D. C., at the price indicated.

ELECTRIC FURNACE REFRACTORIES

In a general study of electric furnace refractories, being made by the Ceramic Experiment Station of the United States Bureau of Mines, Columbus, Ohio, conductivity tests are to be made of alundum, carborundum, sillimanite, spinel, silica, and magnesite.

COÖPERATIVE WORK ON REFRACTORIES

The Bureau of Mines laboratory car Holmes is now at the plant of the American Refractories Company in Baltimore where initiatory work on the coöperative investigation between the Refractories Manufacturers' Association and the Bureau has begun. The objects of this investigation are to decrease fuel consumption in burning refractories, to shorten the time of burning, and to improve the quality of the product.

This coöperation is conducted through a committee of the Refractories Manufacturers' Association, of which S. M. Kier of Pittsburgh is chairman. The car serves as laboratory and living quarters for the crew conducting the investigation, which consists of seven technical men, a cook and a mechanic's helper. The technical force consists of four ceramic engineers and three fuel engineers, all of whom have had experience on problems of this type. The ceramic men are E. P. Ogden, foreman in immediate charge of the work, Alfred Whitford, A. E. Rupp and A. H. Fessler. The fuel engineers are W. E. Rice, car manager, R. F. Lunger and F. Wentzel.

After about a month's stay at the Baltimore plant the car will go to six other plants situated at Brooklyn, N. Y.; Womelsdorf and Salina, Pa.; Hayward Station and Taylor, Ky.; and Ottawa, Ill.

This work is under the immediate supervision of G. A. Bole, superintendent of the Bureau of Mines Ceramic Station, Columbus, Ohio, the fuel and gas work being under the supervision of Mr. John Blizard, fuel engineer of the Pittsburgh station. Mr. Willard D. Richardson, kiln expert, is consultant.

The crew takes data and makes observations during the first test and assumes direction of the burning of the kiln on the second test.

Three conferences of the technical staff and advisors are held with the plant managers, the first one before the first burn, then following the first and before making the second burn, and after the data for both burns are assembled. This brings to the writing of the reports the very best available knowledge both of plant experience and general technical information, a coöperation of the plant and laboratory men that should bring out the largest amount of vital information bearing on kiln economics.

FACE BRICK TESTS OF GEORGIA CLAYS

There is in Georgia a great quantity of impure feldspars and pegmatites which are unfit for use as a pottery ingredient but which, it is hoped, will make satisfactory vitrified face brick when mixed with an appropriate amount of white clay and burned to a dense body. With this idea in mind test pieces have been made up at the Ceramic Experiment Station of the Bureau of Mines, using varying proportions of several different feldspars and clays. The test pieces will be burned at several different temperatures.

BULLETINS ISSUED BY THE DEPARTMENT OF CERAMIC ENGINEERING, UNIVERSITY OF ILLINOIS, URBANA, ILL.

1. Courses in Ceramics. U. of I. Bulletin, Vol. III, No. 3, Nov. 1, 1905. None available.
2. Part 1. Purdy, R. C. and Fox, H. B., "Fritted Glazes," 1907. 45 cents.
   Part 2. Purdy, R. C. and Krehbiel, J. F., "Crystalline Glazes," 1907. 45 cents.
3. Purdy, R. C. and Moore, J. K., "Pyrochemical and Physical Behavior of Clays," Vol. 4, No. 13, U. of I. Bulletin, Mar. 1, 1907. None available.
4. Jones, J. C., "Efflorescence of Brick," 1906. None available.
5. Circular of Department of Ceramic Engineering. None available.
6. Jones, J. C., "Effect of Repeated Freezing and Thawing on Brick Burned to Different Degrees of Hardness," 1907. 25 cents.
7. Bleininger, A. V. and Moore, J. K., "The Influence of Fluxes and Non-fluxes upon the Change in the Porosity and the Specific Gravity of Some Clays," 1908. None available.
8. Bleininger, A. V., "A Study of the Heat Distribution in Four Industrial Kilns," Vol. 5, Aug. 17, 1908. None available.
9. Stull, R. T., "A Cheap Enamel for Stoneware;" Bleininger, A. V., "The Viscosity of Clay Slips," "Note on Some Fusion Curves," 1908. None available.
10. Bleininger, A. V. and Layman, F. E., "A Method Making Possible the Utilization of an Illinois Joint Clay;" Bleininger, A. V., "An Attempt to Determine the Amount of Heat Utilized from a Down-draft Kiln by the Waste Heat Drying System," 1909. 5 cents.
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CALENDAR OF CONVENTIONS

American Association of Flint and Lime Glass Mfrs.—April, 1923.
American Dental Trade Association—Spring Lake, N. J., June, 1923.
American Face Brick Association—First Week in December, 1923.
American Face Brick Association, Southern Group—West Baden, Ind., November, 1923.
American Foundrymen's Association—Cleveland, Ohio, April 30–May 3, 1923.
American Gas Association—October, 1923.
American Hotel Association of United States and Canada—San Francisco, April, 1923.
American Society for Testing Materials—Place not determined, June, 1923.
American Zinc Institute—St. Louis, Mo., May 7 and 8, 1923.
Association of Scientific Apparatus Makers of the United States of America—Washington, D. C., April 20, 1923.
Chamber of Commerce of the United States of America—New York City, May 8–10, 1923.
Clay Products' Association—Chicago, Ill., Third Tuesday in each month.
Dental Manufacturers' Club of the United States—Spring Lake, N. J., June, 1923.
Fire Underwriters' Association of the Northwest—Chicago, Ill., October 17–18, 1923.
Manufacturing Chemists' Association—New York, June, 1923.
National Association of Manufacturers of the United States—New York City, Week of May 14, 1923.
National Association of Stove Manufacturers—Richmond, Va., May 9, 1923.
National Association of Window Glass Manufacturers—Place and date not determined
National Board of Fire Underwriters—New York, May 24, 1923.
National Bottle Manufacturers' Association—Atlantic City, N. J., Last of April, 1923.
National Gas Appliance Manufacturers' Exchange—Kansas City, Mo., May, 1923.
National Gas Association of America—Louisville, Ky., April 23–24, 1923.
National Paving Brick Manufacturers' Association, December, 1923.
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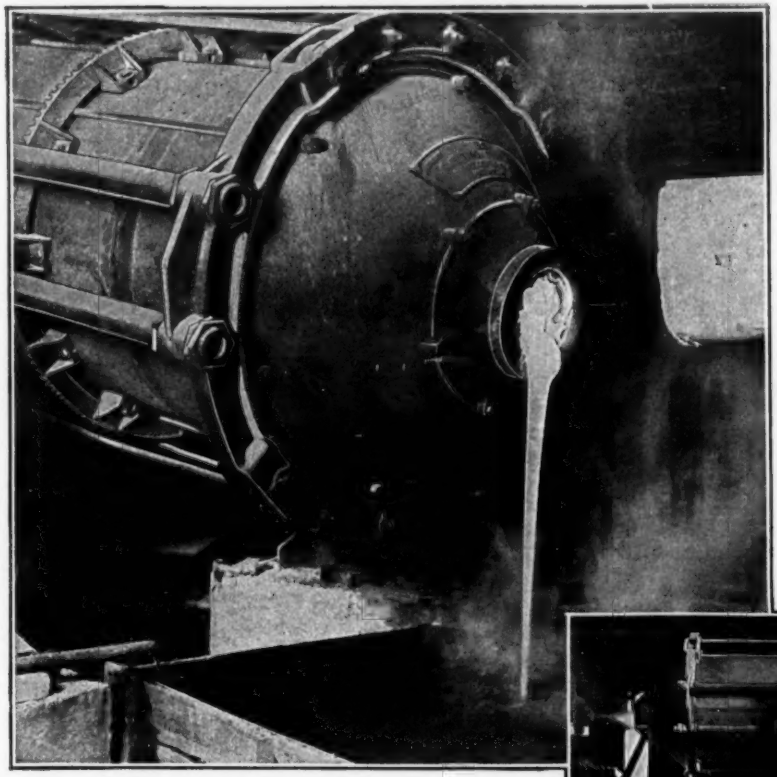

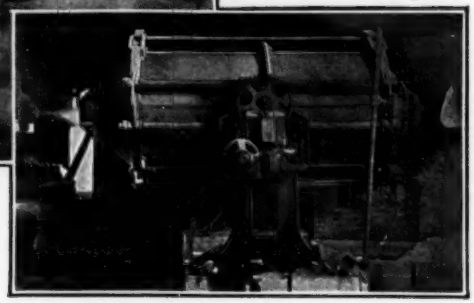

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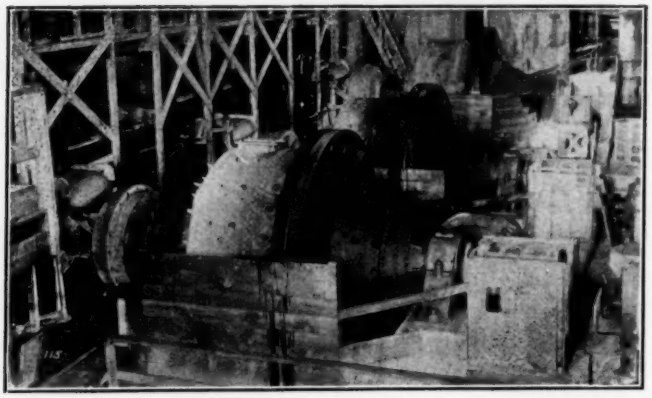

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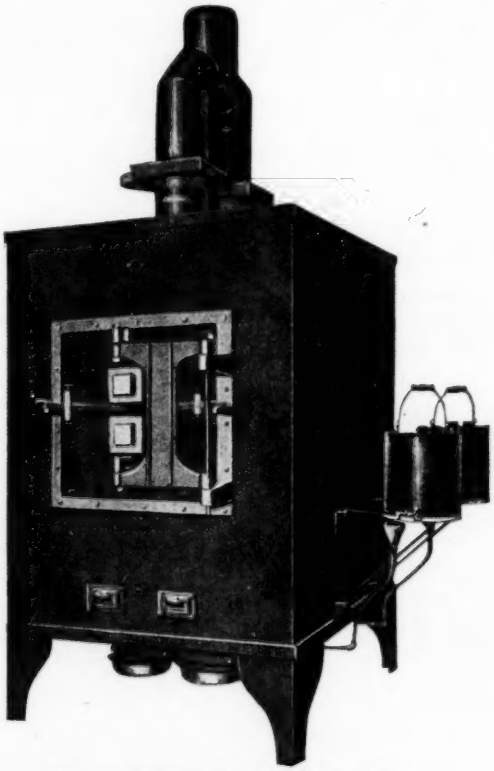

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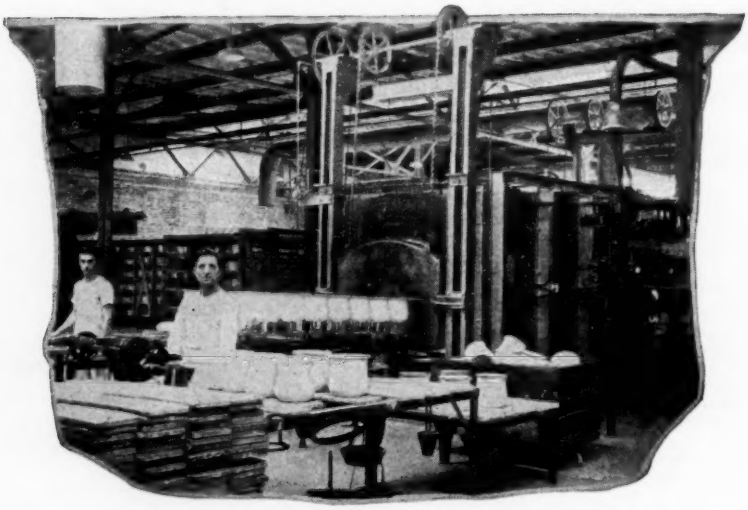

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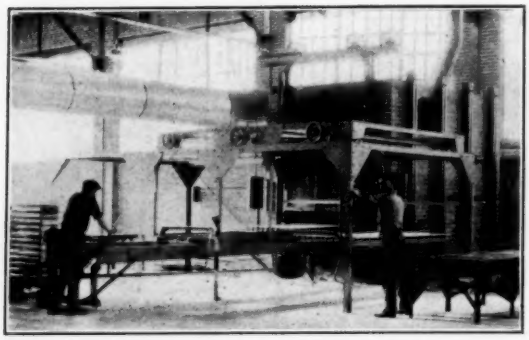

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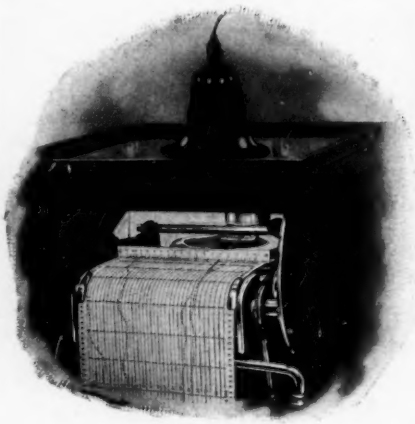

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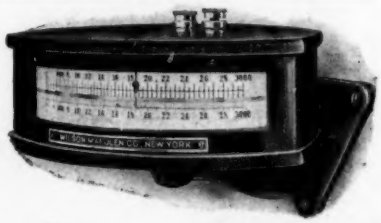

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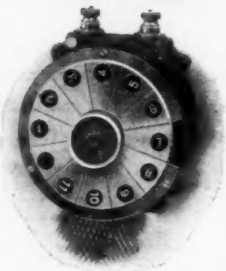

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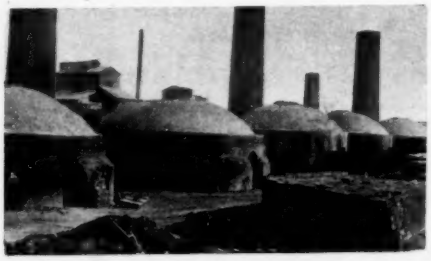

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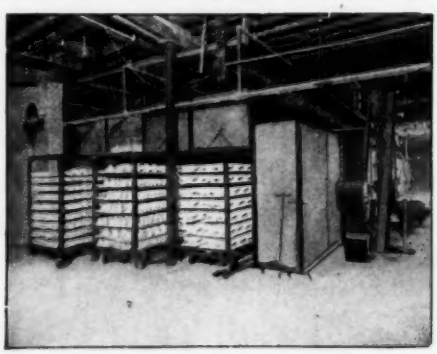

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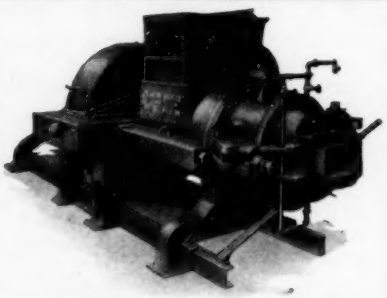

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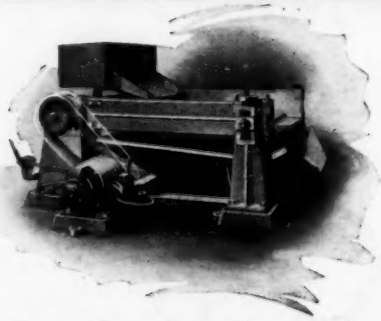

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